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State of California
The Resources Agency
DEPARTMENT OF WATER RESOURCES
San Joaquin District

SAN JOAQUIN VALLEY
DRAINAGE MONITORING PROGRAM
1992

District Report

May 1995

PETE WILSON
Governor
State of California

DOUGLAS P. WHEELER
Secretary for Resources
The Resources Agency

DAVID N. KENNEDY
Director
Department of Water Resources

Copies of this report are available without charge from:

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D-037604

FOREWORD

This annual report, the thirtieth in a series, presents statistical data on the quality and quantity of agricultural drainage water in the San Joaquin Valley. California Department of Water Resources staff collects and interprets these data to identify drainage problem areas and plan drainage management projects.

This report contains data collected for the 1992 calendar year and includes graphs showing trends indicated by these data. Included in the report is a map and acreage of present and potential drainage problem areas. The report also contains the results of a ground water synoptic study by the U.S. Geological Survey in cooperation with the Department of Water Resources.

The Department of Water Resources invites comments and suggestions concerning the report itself and the scope and conduct of its ongoing data-gathering effort.

Louis A. Beck, Chief
San Joaquin District

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STATE OF CALIFORNIA
Pete Wilson, Governor

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INTRODUCTION

Monitoring of agricultural drainage water in the San Joaquin Valley began in 1959 as a cooperative effort between the California Department of Water Resources and the University of California. In 1963, the monitoring program became part of DWR's San Joaquin Drainage Investigation. Although the investigation ended in 1970, the monitoring program continued as a separate departmental activity until 1975, when DWR, the U.S. Bureau of Reclamation, and the State Water Resources Control Board formed the Interagency Drainage Program. The monitoring program was continued from June 1975 to June 1979 to provide technical assistance to IDP. When IDP ended in June 1979, the DWR monitoring program was resumed as a separate activity under DWR's Agricultural Drainage Program.

In 1983, waterfowl deformities detected at Kesterson Reservoir, the interim terminus of the federal San Luis Drain, resulted in a new interagency drainage study — the San Joaquin Valley Drainage Program — which completed its final report in September 1990. In December 1991, several State and federal agencies signed a memorandum of understanding and released an implementation strategy which included a commitment to a long-term program to monitor drainage conditions and the impacts of actions to manage drainage problems. The DWR monitoring program will be continuously evaluated and modified to meet the monitoring needs of the implementation strategy.

DRAINAGE PROBLEM AREAS

The San Joaquin Valley is a rich agricultural region that encompasses large areas with high water tables. The elevations of these water tables are influenced by irrigation practices, cropping patterns, and unlined ditches or ponds. DWR defines "problem areas" as locations where the water table is within 5 feet of the ground surface any time during the year. Table 1 presents the acreage of present and potential drainage problem areas in spring 1993. Plate 1 (bound at back of report) geographically illustrates the Valley's drainage problem areas in spring 1993. The map shows areas considered to be present problem areas where the water table is within 5 feet of the soil surface. Areas where the water table is between 5 and 20 feet below the soil surface are considered to be potential problem areas.

In preparing the map and table, items such as existing drainage systems, wildlife refuges, urban areas, pasture land, and native vegetation were not taken into account. In these areas, especially refuges and urban areas, the extent of shallow ground water may be overstated and should be investigated separately before making projections about whether these areas will require drainage systems in the future. Most of the data used to complete these statistics were obtained from local agencies; the remainder came from depth measurements made by DWR.

TABLE 1

ACREAGE WITH PRESENT AND POTENTIAL
DRAINAGE PROBLEMS IN SAN JOAQUIN VALLEY
SPRING 1993
(acres)

Area*	0- to 5-Foot Depth	5- to 10-Foot Depth	10- to 15-Foot Depth	15- to 20-Foot Depth	Total
Grasslands	148,000	137,000	102,000	25,000	412,000
Westlands	70,000	172,000	87,000	66,000	395,000
Tulare	203,000	151,000	34,000	0	388,000
Kern	24,000	124,000	164,000	25,000	337,000
Total	445,000	584,000	387,000	116,000	1,532,000

*Areas are consistent with those defined in the San Joaquin Valley Drainage Program's September 1990 report entitled *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*. The northern area referred to in that report is not included since the area is not part of this study.

1992 DRAINAGE MONITORING PROGRAM

DWR's 1992 San Joaquin Valley drainage monitoring activities consisted of collecting water samples from 28 subsurface and 2 surface drains in the areas shown on Figure 1. Figure 2 shows the specific locations of the central area drains, while Figure 3 shows the sites of the southern area drains. DWR has not routinely monitored the northern area since 1969 because USBR handles drainage monitoring from Tracy to Gustine. USBR also collects data on various drainage systems in the San Luis and Delta-Mendota service areas and publishes these data as they become available.

The number of drains sampled in the central and southern areas in 1992 was one less than in 1991. Table 2 lists the drains sampled during the 1992 program.

TABLE 2

1992 DRAINAGE MONITORING STATIONS

Central Area	Southern Area
BVS 6016	CCN 3550
BVS 8003	CNR 0801
CTL 4504*	COC 4126
DPS 1367	COC 5329
DPS 2535	ERR 7525
DPS 3235*	ERR 8429
DPS 3465	ERR 8641
DPS 4616	GSY 0855
FBH 2016	HCH 7439
FBH 8061	LNW 5454
HMH 7516	LNW 5467
	LNW 6459
	LNW 6467
	SFD 2727
	STC 3505
	STC 5436
	VGD 3906
	VGD 4406
	VGD 5412

*Surface drain

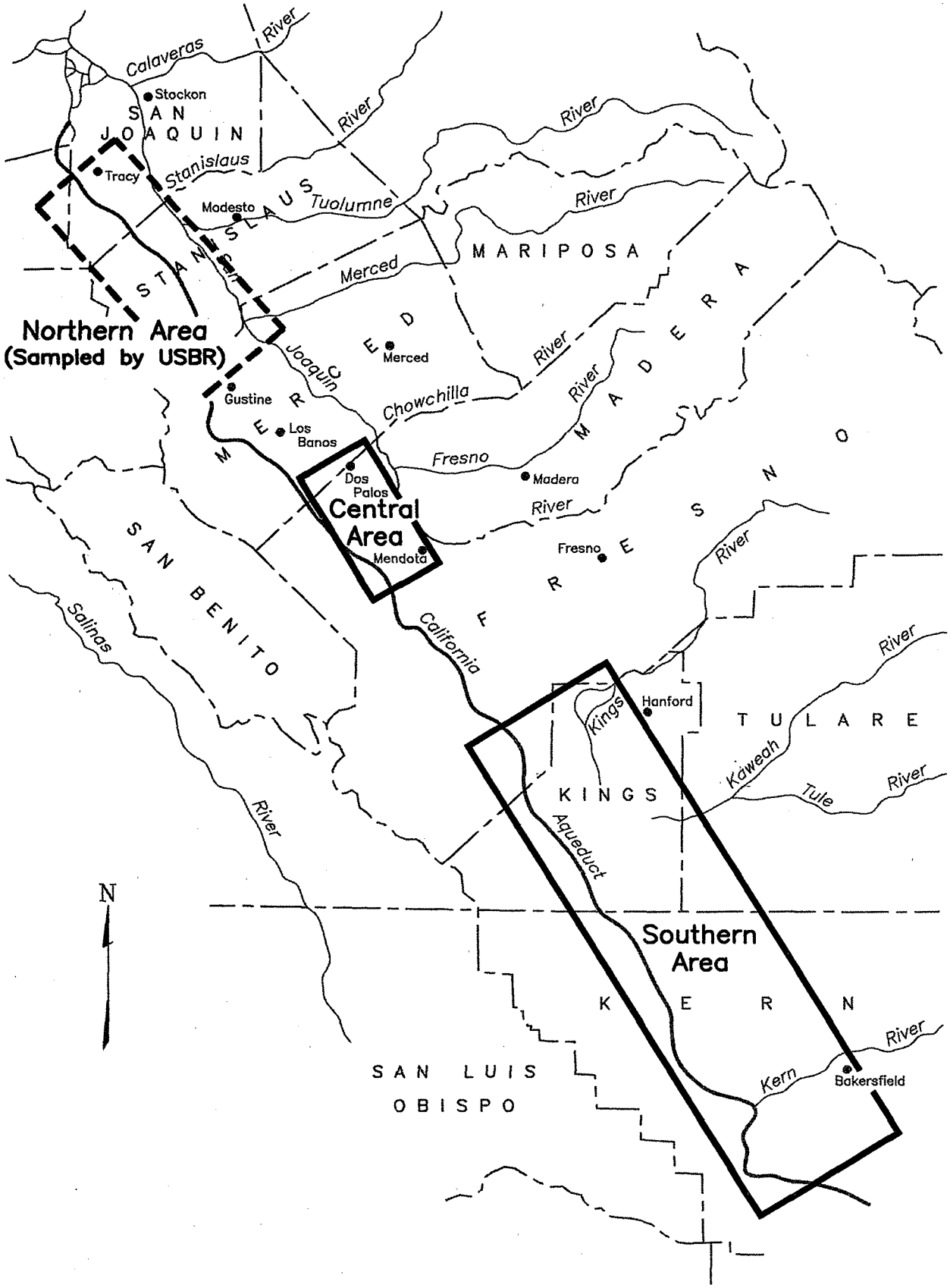


Figure 1. Overview of Sampling Area Locations

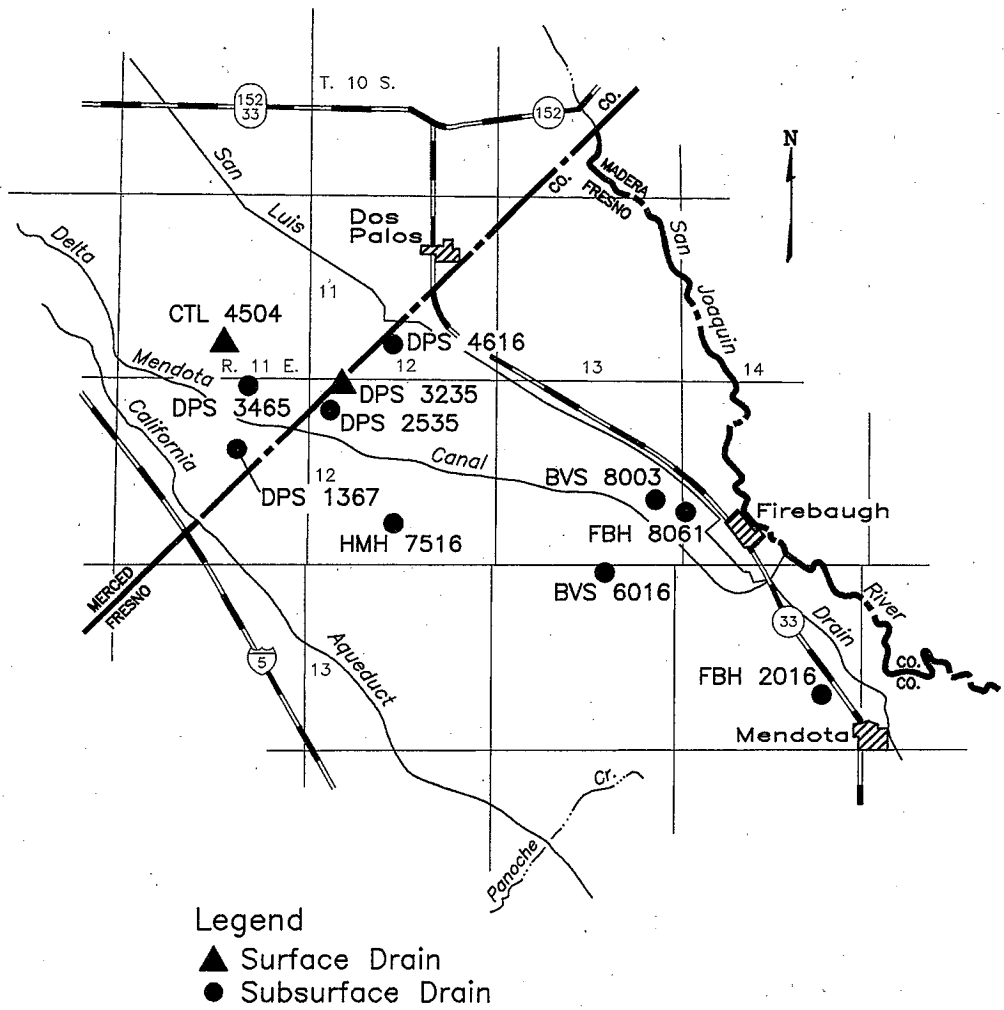
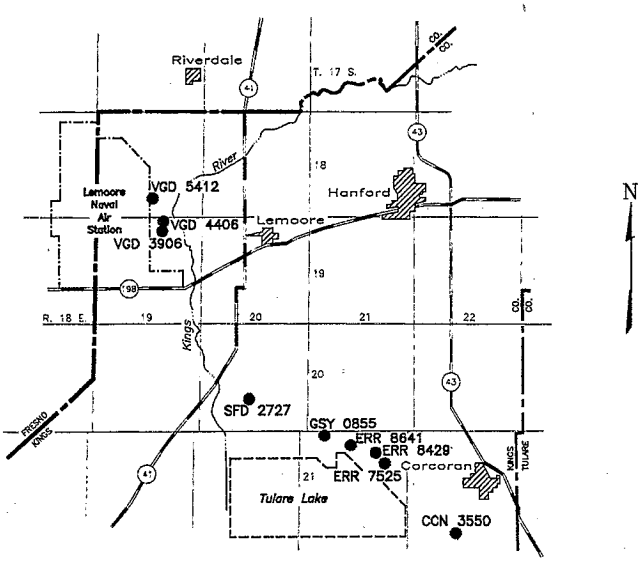
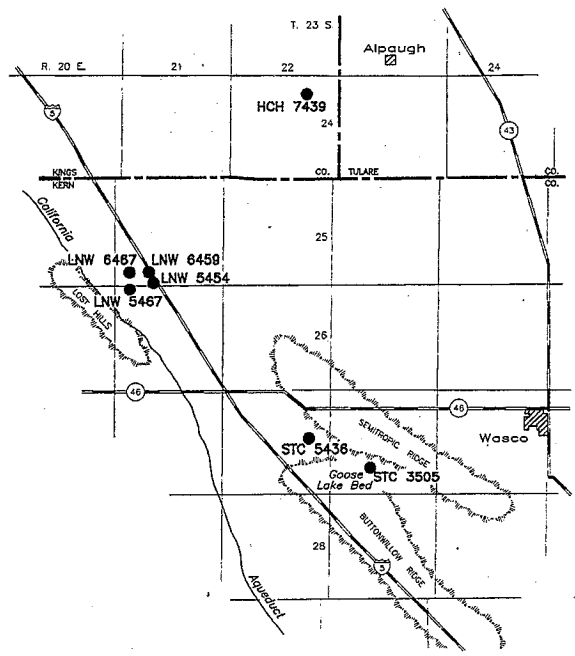


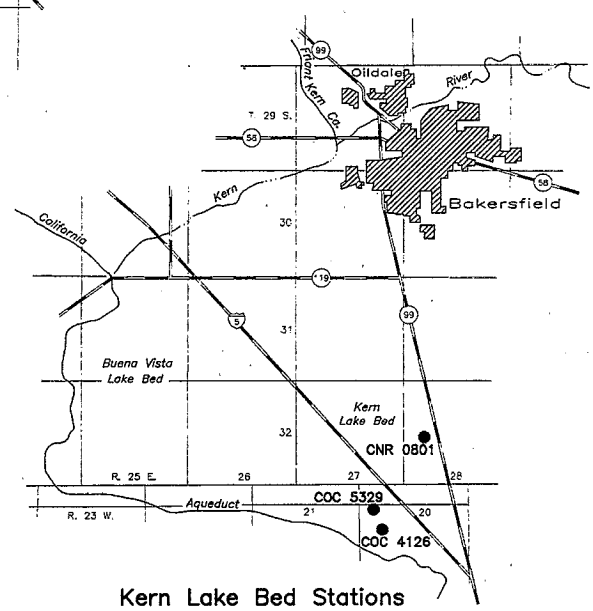
Figure 2. Central Area Drain Locations



Lemoore/Corcoran Stations



Lost Hills/Semitropic Stations



Kern Lake Bed Stations

Figure 3. Southern Area Drain Locations

Flows

The 1992 flow monitoring program collected data for each drain's total flow volume by converting sump pump power use into acre-feet or by reading flow meters directly.

Table 3 presents results of the 1992 flow monitoring program. Caution should be exercised in using these results. In many cases, flow was estimated or averaged due to missing records. Also, many drains receive ground water from areas outside the drainage pipe collector network. Depending on the soil surrounding the drain, one month's flow may consist of part of the previous month's irrigations. Also, one drainage sump may act as a collector point for six or more drainage pipe systems.

Pesticides

The 1992 drainage monitoring program did not include testing for pesticides, since only very low concentrations of chlorinated hydrocarbon or organic phosphorous pesticides have been found in the past.

Nutrients

The 1992 drainage monitoring program did not sample subsurface drains for nutrients. In the past, nutrient data were analyzed for correlation of nutrient values versus the time of year when sampled. These correlations, however, were difficult to evaluate due to:

1. Overirrigation, which leads to increased leaching of salts from soils
2. Variable commercial fertilizer application rates
3. Yearly sample value fluctuations
4. Variable soil types

Mineral Constituent Concentrations

Table 4 summarizes mineral concentrations detected in subsurface and surface drains for the central and southern areas, including arithmetic averages and geometric means. Table 5 shows the 1992 mineral constituents for the central area. Table 6 lists the results for the southern area. The principal minerals present in subsurface drain water are sodium and sulfate. Mineral constituents that appear in water as salts directly affect the electrical conductivity (EC) of the water. EC has been found to closely correlate with sodium and sulfate, as shown in DWR drainage monitoring reports for the years 1974 through 1976.

In the central area subsurface drains, sodium concentrations ranged from 196 to 2,590 milligrams per liter (mg/L), with an arithmetic average of 987 mg/L. Sulfate ranged from 885 to 5,310 mg/L with an arithmetic average of 2,267 mg/L. In the southern area, sodium had levels from 369 to 17,200 mg/L. Sulfate concentrations ranged from 550 to 16,800 mg/L, with an arithmetic average of 6,118 mg/L. EC varied from 2,490 to 54,400 microsiemens per centimeter (μS/cm).

TABLE 3

SUBSURFACE DRAIN FLOWS
1992
(acre-feet unless otherwise indicated)

Station	Area Tiled (acres)	Jan*	Feb	Mar*	Apr	May*	Jun	Jul*	Aug	Sep*	Oct	Nov*	Dec	Total	Average Water Drained (acre-feet per acre)
Central Area															
BVS 6016	740	0.0	0.2	0.2	3.1	3.1	12.6	12.6	0.6	0.6	0.0	0.0	28.4b	61.4	0.08
BVS 8003	110	1.3	5.1	5.1	6.7	6.7	2.1	2.1	9.6	9.6	2.1	2.1	3.8b	56.3	0.51
DPS 1367	120	8.1	19.1	19.1	34.0	34.0a	34.0	34.0	36.9	36.9	12.3	12.3	21.2b	301.9	2.52
DPS 2535	320	6.7	16.2	16.2	34.6	34.6	23.4	23.4	11.0	11.0	4.8	4.8	16.2b	202.9	0.63
DPS 3465	160	5.2	4.9	4.9	6.7	6.7	6.4	6.4	13.9	13.9	3.6	3.6	6.7b	82.9	0.52
DPS 4616	140	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0b	7.3	0.05
FGH 2016	81	3.4	10.3	10.3	0.4	0.4	0.9	0.9	11.1	11.1	0.0	0.0	0.1b	48.9	0.60
FBH 8061	320	2.9	0.0	0.0	32.3	32.3	30.7	30.7	23.5	23.5	18.6	18.6	22.4b	235.5	0.74
Southern Area															
CCN 3550	880	1.8	12.0	12.0	5.5	5.5	5.9	5.9	6.8	6.8	3.3	3.3	6.6b	75.4	0.09
ERR 7525	220	10.7	26.0	26.0	37.8	37.8	8.6	8.6	1.7	1.7	0.3	0.3	9.8b	169.3	0.77
ERR 8641	258	6.3	19.3	19.3	19.7	19.7	6.0	6.0	19.9	19.9	10.8	10.8	9.7b	167.4	0.65
GSY 0855	60	0.0	2.2	2.2	7.5	7.5a	7.5	7.5	0.0	0.0	0.0	0.0	0.0b	34.4	0.57
LNW 6459	581	0.0a	0.0	0.0	8.8	8.8a	8.8	8.8	37.0	37.0	15.5	15.5	10.1c	150.3	0.26
LNW 6467	1,420	9.9	9.5	9.5	24.4	24.4	32.8	32.8	43.0	43.0	11.1	11.1	11.1c	262.6	0.18
SFD 2727	120	0.1	4.1	4.1	4.3	4.3	4.5	4.5	1.4	1.4	0.2	0.2	0.2b	29.3	0.24
SFD 6046	160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0b	0.0	0.00
STC 5436	153	0.8a	0.8	0.8	16.5	16.5	6.8	6.8	0.0	0.0	0.0	0.0	0.0b	49.0	0.32
STC 6467	124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0b	0.0	0.00
VGD 3906	870	15.8a	15.8	15.8	21.3	21.3	16.3	16.3	20.4	20.4	5.2	5.2	12.6c	186.4	0.21
VGD 4406	310	14.5	32.0	32.0	27.4	27.4	24.0	24.0	31.3	31.3	9.6	9.6	14.8c	277.9	0.90
VGD 5412	275	4.8	18.1	18.1	41.0	41.0	18.1	18.1	16.0	16.0	5.6	5.6	16.0c	218.4	0.79

* Denotes months that sump meter was read (averaged with alternate months).
a/ Flow was averaged due to missing records (meter was not read).
b/ Flow was averaged for period of December 1992 through March 1993.
c/ Flow was averaged for period of December 1992 through February 1993.

TABLE 4

SUMMARY OF MINERALS DETECTED
1992
(milligrams per liter unless otherwise indicated)

Element	Subsurface Drains				Surface Drains			
	Maximum	Minimum	Arithmetic Average	Geometric Mean	Maximum	Minimum	Arithmetic Average	Geometric Mean
				Central Area				
Sodium	2,590	196	987	807	751	536	677	659
Calcium	635	213	419	404	429	263	330	322
Magnesium	481	47	178	150	186	83	110	108
Potassium	5.0	1.0	2.7	2.5	4.0	3.0	3.5	3.5
Alkalinity as $CaCO_3$	346	120	198	186	174	167	171	171
Sulfate	5,310	885	2,267	1,942	1,670	1,560	1,615	1,614
Chloride	1,810	136	827	633	698	618	658	657
Nitrate	241	1.0	102	70	164	49	118	110
Boron	60	2.5	14.5	10.3	9.6	5.0	8.1	7.9
TDS	11,500	1,860	5,211	4,633	3,870	2,950	3,557	3,487
EC (µS/cm)	13,000	2,310	6,452	5,859	5,180	4,000	4,765	4,677
				Southern Area				
Sodium	17,200	369	3,850	2,195				
Calcium	663	31	346	251				
Magnesium	1,490	6	348	182				
Potassium	37	1.0	7.8	4.9				
Alkalinity as $CaCO_3$	802	143	405	361				
Sulfate	16,800	550	6,118	3,887				
Chloride	5,850	233	1,669	1,027				
Nitrate	407	1.0	114	54				
Boron	52	0.8	16.9	8.27				
TDS	46,200	1,750	13,859	8,738				
EC (µS/cm)	54,400	2,490	15,431	10,541				

TABLE 5

MINERAL ANALYSES OF CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	EC (µS/cm)	Mineral Constituents in : Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS Sum	TH NCH	SAR ASAR as CaCO3
BVS 6016	01/14/92	14.0	7.5	7,493	534	216	887	-	-	-	-	128	6.5	5,210	2,220	8.1
	1300	57.2	-	6,420	26.65	17.76	38.58	-	-	-	-	2.06		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	17.0	7.5	4,744	327	145	652	5	174	1,660	603	113	4.6	3,730	1,410	7.5
	1250	62.6	8.0	4,860	16.32	11.92	28.36	0.13	3.48	34.53	17.00	1.82		3,679	1,236	17.8
					29	21	50	0	6	61	30	3				
	05/13/92	19.0	7.3	5,616	364	144	794	-	-	-	-	213	5.5	4,390	1,500	8.9
	1000	66.2	-	5,680	18.16	11.84	34.54	-	-	-	-	3.43		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	21.0	6.6	5,508	415	176	795	-	-	-	-	131	5.5	4,540	1,760	8.2
	0930	69.8	-	5,760	20.71	14.47	34.58	-	-	-	-	2.11		-	-	-
					-	-	-	-	-	-	-	-				
BVS 8003	01/14/92	16.0	7.5	9,680	394	249	1,590	-	-	-	-	21	20.0	7,560	2,010	15.4
	1320	60.8	-	8,570	19.66	20.47	69.17	-	-	-	-	0.34		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	16.0	7.3	6,897	372	223	1,580	3	208	3,790	774	104	18.0	7,290	1,850	15.9
	1310	60.8	8.0	8,610	18.56	18.33	68.73	0.06	4.16	78.83	21.83	1.67		7,054	1,642	38.3
					18	17	65	0	4	74	20	2				
	07/08/92	22.0	7.4	11,024	420	298	2,250	-	-	-	-	55	25.0	9,870	2,280	20.5
	0945	71.6	-	11,300	20.96	24.50	97.87	-	-	-	-	0.89		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	19.0	7.3	7,119	324	185	1,260	-	-	-	-	26	15.0	5,840	1,570	13.8
	0945	66.2	-	6,800	16.17	15.21	54.81	-	-	-	-	0.42		-	-	-
					-	-	-	-	-	-	-	-				
CTL 4504	01/14/92	7.0	8.0	5,168	366	105	690	-	-	-	-	110	9.1	3,660	1,350	8.1
	1045	44.6	-	4,880	18.26	8.63	30.02	-	-	-	-	1.77		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	15.0	8.3	4,898	333	113	740	4	167	1,670	618	125	9.0	3,850	1,300	8.9
	0930	59.0	8.1	5,050	16.62	9.29	32.19	0.10	3.34	34.74	17.43	2.01		3,770	1,133	20.9
					29	16	55	0	6	60	30	3				
	05/13/92	24.0	8.3	3,968	271	83	536	-	-	-	-	97	6.4	2,950	1,020	7.3
	1400	75.2	-	4,000	13.52	6.82	23.32	-	-	-	-	1.56		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	27.0	8.3	4,310	429	96	552	-	-	-	-	130	5.0	3,370	1,470	6.2
	1200	80.6	-	4,440	21.41	7.89	24.01	-	-	-	-	2.09		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 5 (continued)

MINERAL ANALYSES OF CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
CTL 4504	11/12/92	12.0	7.9	4,456	263	98	631	-	-	-	-	49	7.1	3,250	1,060	8.4
	1300	53.6	-	4,340	13.12	8.06	27.45	-	-	-	-	0.79		-	-	-
					-	-	-	-	-	-	-	-				
DPS 1367	01/14/92	15.0	7.3	5,828	632	133	525	-	-	-	-	190	5.8	4,080	2,130	4.9
	1020	59.0	-	5,370	31.54	10.93	22.84	-	-	-	-	3.06		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	17.0	7.4	5,086	550	130	523	2	120	1,330	924	212	5.4	3,960	1,910	5.2
	1000	62.6	7.9	5,300	27.45	10.69	22.75	0.06	2.40	27.66	26.06	3.41		3,791	1,790	12.5
					45	18	37	0	4	46	44	6				
	05/13/92	20.0	7.4	5,106	507	120	526	-	-	-	-	241	5.8	3,950	1,760	5.4
	1315	68.0	-	5,210	25.30	9.86	22.88	-	-	-	-	3.88		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	21.0	7.4	-	635	137	532	-	-	-	-	218	5.3	4,140	2,150	4.9
	1115	69.8	-	5,450	31.69	11.26	23.14	-	-	-	-	3.51		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	19.0	7.4	5,650	565	137	517	-	-	-	-	217	5.3	4,180	1,970	5.0
	1200	66.2	-	5,490	28.19	11.26	22.49	-	-	-	-	3.49		-	-	-
					-	-	-	-	-	-	-	-				
DPS 2535	01/14/92	14.0	7.3	9,144	453	177	1,280	-	-	-	-	76	18.0	6,050	1,860	12.9
	1120	57.2	-	7,870	22.60	14.55	55.68	-	-	-	-	1.22		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	17.0	7.1	7,670	439	181	1,410	3	203	2,550	1,220	94	18.0	6,340	1,840	14.2
	1045	62.6	7.9	8,170	21.91	14.88	61.34	0.06	4.06	53.04	34.40	1.51		6,100	1,637	35.3
					22	15	62	0	4	57	37	2				
	05/13/92	19.0	7.4	8,475	430	191	1,470	-	-	-	-	104	19.0	6,690	1,860	14.8
	1230	66.2	-	8,690	21.46	15.70	63.95	-	-	-	-	1.67		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	20.0	7.3	9,213	503	218	1,560	-	-	-	-	98	20.0	7,160	2,150	14.6
	1100	68.0	-	9,190	25.10	17.92	67.86	-	-	-	-	1.58		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	19.0	7.1	12,769	588	319	2,120	-	-	-	-	98	24.0	9,890	2,780	17.4
	1120	66.2	-	12,300	29.34	26.22	92.22	-	-	-	-	1.58		-	-	-
					-	-	-	-	-	-	-	-				
DPS 3235	01/14/92	9.0	8.0	5,184	344	98	693	-	-	-	-	131	9.6	3,600	1,260	8.4
	1200	48.2	-	4,850	17.17	8.06	30.15	-	-	-	-	2.11		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 5 (continued)

MINERAL ANALYSES OF CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	Field Laboratory EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS Sum	TH NCH	SAR / ASAR as CaCO3
DPS 3235	03/11/92	17.0	8.0	4,956	349	107	751	3	174	1,560	698	163	9.3	3,870	1,310	9.0
	1115	62.6	8.1	5,180	17.42	8.80	32.67	0.08	3.48	32.45	19.68	2.62		3,805	1,136	21.5
					30	15	55	0	6	56	34	5				
	05/13/92	23.0	8.3	5,002	328	104	739	-	-	-	-	164	9.3	3,740	1,250	9.1
	1130	73.4	-	5,100	16.37	8.55	32.15	-	-	-	-	2.64		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	25.0		4,650	321	186	708	-	-	-	-	129	7.5	3,570	1,570	7.7
	1030	77.0	-	4,790	16.02	15.29	30.80	-	-	-	-	2.08		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	14.0	8.3	5,067	299	111	734	-	-	-	-	78	9.1	3,710	1,200	9.2
	1340	57.2	-	5,020	14.92	9.12	31.93	-	-	-	-	1.26		-	-	-
					-	-	-	-	-	-	-	-				
DPS 3465	01/14/92	14.0	7.0	8,255	495	184	1,020	-	-	-	-	90	15.0	5,500	1,990	9.9
	1100	57.2	-	7,110	24.70	15.12	44.37	-	-	-	-	1.45		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	15.0	7.0	7,440	536	207	1,150	3	346	2,220	1,300	94	15.0	5,990	2,190	10.6
	1030	59.0	7.9	7,660	26.75	17.02	50.02	0.08	6.92	46.18	36.66	1.51		5,856	1,844	29.8
					28	18	53	0	8	51	40	2				
	05/13/92	18.0	7.1	6,095	433	171	872	-	-	-	-	105	12.0	4,740	1,780	8.9
	1330	64.4	-	6,350	21.61	14.06	37.93	-	-	-	-	1.69		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	21.0	7.0	6,912	476	196	1,020	-	-	-	-	115	15.0	5,380	2,000	9.9
	1145	69.8	-	7,050	23.75	16.11	44.37	-	-	-	-	1.85		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	19.0	7.0	7,006	503	179	987	-	-	-	-	74	14.0	5,350	1,990	9.6
	1230	66.2	-	6,810	25.10	14.71	42.93	-	-	-	-	1.19		-	-	-
					-	-	-	-	-	-	-	-				
DPS 4616	01/14/92	14.0	7.3	12,192	451	368	1,910	-	-	-	-	33	50.0	9,310	2,640	16.1
	1230	57.2	-	10,700	22.50	30.25	83.08	-	-	-	-	0.53		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	14.0	7.4	12,700	494	464	2,590	3	293	5,310	1,810	42	60.0	11,500	3,140	20.0
	1130	57.2	7.9	13,000	24.65	38.14	112.67	0.08	5.86	110.45	51.04	0.68		11,006	2,847	51.9
					14	22	64	0	3	66	30	0				
	11/12/92	18.0	7.3	11,730	470	481	2,310	-	-	-	-	42	57.0	11,200	3,150	17.8
	1420	64.4	-	12,400	23.45	39.54	100.48	-	-	-	-	0.68		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 5 (continued)

MINERAL ANALYSES OF CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	EC (µS/cm)	Mineral Constituents in : Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS Sum	TH NCH	SAR / ASAR as CaCO3
FBH 2016	01/14/92	14.0	8.0	8,001	446	260	1,110	-	-	-	-	26	12.0	6,310	2,180	10.3
	1400	57.2	-	6,980	22.26	21.37	48.28	-	-	-	-	0.42		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	16.0	7.4	-	311	96	318	1	162	1,350	210	6	3.4	2,560	1,170	4.0
	1345	60.8	8.1	3,100	15.52	7.89	13.83	0.04	3.24	28.08	5.92	0.09		2,454	1,008	9.5
					42	21	37	0	9	75	16	0				
FBH 8061	01/14/92	15.0	7.5	2,542	278	56	196	-	-	-	-	1	2.5	1,860	925	2.8
	1335	59.0	-	2,310	13.87	4.60	8.53	-	-	-	-	0.01		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	15.0	7.4	6,448	339	84	222	1	122	1,310	136	7	3.0	2,370	1,190	2.7
	1320	59.0	8.1	2,730	16.92	6.90	9.66	0.03	2.44	27.25	3.84	0.11		-	1,068	-
					50	21	29	0	7	81	11	0				
	05/13/92	18.0	7.5	5,037	406	162	721	-	-	-	-	32	9.3	4,370	1,680	7.6
	0900	64.4	-	5,140	20.26	13.32	31.36	-	-	-	-	0.52		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	21.0	7.4	5,238	390	168	802	-	-	-	-	41	9.5	4,620	1,660	8.5
	0830	69.8	-	5,400	19.46	13.81	34.89	-	-	-	-	0.66		-	-	-
					-	-	-	-	-	-	-	-				
	11/12/92	19.0	7.3	4,441	348	156	598	-	-	-	-	40	7.0	3,700	1,510	6.6
	0915	66.2	-	4,400	17.37	12.82	26.01	-	-	-	-	0.64		-	-	-
					-	-	-	-	-	-	-	-				
HMH 7516	01/14/92	16.0	6.1	3,739	272	56	424	-	-	-	-	145	7.1	2,420	910	6.1
	0930	60.8	-	3,410	13.57	4.60	18.44	-	-	-	-	2.33		-	-	-
					-	-	-	-	-	-	-	-				
	03/11/92	18.0	7.3	3,278	274	55	417	3	154	885	464	160	6.1	2,430	910	6.0
	1230	64.4	8.0	3,410	13.67	4.52	18.14	0.08	3.08	18.41	13.08	2.58		-	756	-
					38	12	50	0	8	50	35	7				
	05/13/92	20.0	7.3	2,908	235	47	372	-	-	-	-	157	6.0	2,020	781	5.7
	1045	68.0	-	3,000	11.73	3.86	16.18	-	-	-	-	2.53		-	-	-
					-	-	-	-	-	-	-	-				
	07/08/92	21.0	7.1	2,808	213	47	370	-	-	-	-	128	5.5	1,960	726	5.9
	0945	69.8	-	2,890	10.63	3.86	16.10	-	-	-	-	2.06		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	22.0	7.3	3,350	254	53	399	-	-	-	-	153	6.6	2,400	852	5.9
	0915	71.6	-	3,410	12.67	4.36	17.36	-	-	-	-	2.46		-	-	-
					-	-	-	-	-	-	-	-				

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TABLE 5 (continued)

MINERAL ANALYSES OF CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field / Laboratory pH	EC (µS/cm)	Mineral Constituents in : Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
HMH 7516	11/12/92	20.0	7.3	3,419	256	52	420	-	-	-	-	148	6.8	2,350	853	6.2
	1045	68.0	-	3,310	12.77	4.27	18.27	-	-	-	-	2.38		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 6

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	Field Laboratory EC (µS/cm)	Mineral Constituents in : Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
CCN 3550	01/14/92	14.0	6.9	2,900	203	94	535	-	-	-	-	21	0.8	2,720	894	7.7
	1000	57.2	-	3,710	10.13	7.73	23.27	-	-	-	-	0.34		-	-	-
					-	-	-	-	-	-	-	-				
	03/10/92	16.0	7.3	6,050	288	158	880	5	398	1,770	689	112	1.2	4,350	1,370	10.3
	1015	60.8	8.0	5,720	14.37	12.99	38.28	0.12	7.96	36.82	19.43	1.80		4,300	972	27.3
					22	20	58	0	12	56	29	3				
	05/12/92	16.0	7.4	5,596	268	131	779	-	-	-	-	104	1.1	3,730	1,210	9.7
	0800	60.8	-	5,050	13.37	10.77	33.89	-	-	-	-	1.67		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	21.0	7.1	4,131	226	104	658	-	-	-	-	73	1.0	3,080	993	9.0
	0915	69.8	-	4,250	11.28	8.55	28.62	-	-	-	-	1.18		-	-	-
					-	-	-	-	-	-	-	-				
	11/06/92	20.0	7.1	4,620	226	111	699	-	-	-	-	50	1.1	3,510	1,020	9.5
	0915	68.0	-	4,730	11.28	9.12	30.41	-	-	-	-	0.81		-	-	-
					-	-	-	-	-	-	-	-				
CNR 0801	01/13/92	17.0	7.8	8,850	311	226	1,820	-	-	-	-	7	21.0	7,910	1,710	19.1
	1440	62.6	-	9,070	15.52	18.58	79.17	-	-	-	-	0.11		-	-	-
					-	-	-	-	-	-	-	-				
	05/11/92	18.0	7.1	10,350	277	220	1,750	-	-	-	-	26	20.0	7,640	1,600	19.0
	1300	64.4	-	8,810	13.82	18.08	76.12	-	-	-	-	0.42		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	23.0	7.4	5,304	194	67	1,180	-	-	-	-	20	13.0	4,880	760	18.6
	1200	73.4	-	6,030	9.68	5.51	51.33	-	-	-	-	0.32		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	23.0	7.6	2,392	127	65	369	-	-	-	-	20	3.9	1,830	585	6.6
	1415	73.4	-	2,490	6.34	5.34	16.05	-	-	-	-	0.32		-	-	-
					-	-	-	-	-	-	-	-				
COC 4126	01/13/92	17.0	7.4	4,868	636	171	656	-	-	-	-	300	3.2	4,700	2,290	5.9
	1310	62.6	-	5,180	31.74	14.06	28.54	-	-	-	-	4.83		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	17.0	7.3	5,546	558	157	624	7	261	2,500	233	323	3.2	4,780	2,040	6.0
	1400	62.6	8.0	5,270	27.84	12.91	27.14	0.17	5.22	52.00	6.57	5.20		4,663	1,779	16.4
					41	19	40	0	8	75	10	8				
	05/11/92	18.0	7.3	6,325	567	158	663	-	-	-	-	407	3.2	4,910	2,070	6.3
	1345	64.4	-	5,450	28.29	12.99	28.84	-	-	-	-	6.55		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value — Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter: B	TDS Sum	TH NCH	SAR / ASAR as CaCO3
COC 4126	07/06/92	21.0	7.5	4,887	617	159	614	-	-	-	-	276	3.0	4,630	2,200	5.7
	1230	69.8	-	5,150	30.79	13.07	26.71	-	-	-	-	4.44		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	23.0	7.5	5,002	466	127	535	-	-	-	-	254	3.0	4,660	1,690	5.6
	1445	73.4	-	5,100	23.25	10.44	23.27	-	-	-	-	4.09		-	-	-
					-	-	-	-	-	-	-	-				
COC 5329	01/13/92	16.0	7.0	7,865	654	203	1,250	-	-	-	-	167	9.8	6,600	2,470	10.9
	1300	60.8	-	7,920	32.63	16.69	54.38	-	-	-	-	2.69		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	24.0	7.5	7,038	649	198	1,200	-	-	-	-	226	7.5	6,420	2,440	10.5
	1130	75.2	-	7,530	32.39	16.28	52.20	-	-	-	-	3.64		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	23.0	7.3	6,760	562	176	1,040	-	-	-	-	325	7.0	6,120	2,130	9.8
	1345	73.4	-	7,080	28.04	14.47	45.24	-	-	-	-	5.23		-	-	-
					-	-	-	-	-	-	-	-				
ERR 7525	01/14/92	16.0	7.5	5,082	182	82	952	-	-	-	-	43	3.0	3,800	792	14.7
	1100	60.8	-	5,050	9.08	6.74	41.41	-	-	-	-	0.69		-	-	-
					-	-	-	-	-	-	-	-				
	03/10/92	17.0	7.5	5,930	194	107	1,150	7	619	1,970	490	102	2.9	4,510	925	16.4
	1100	62.6	8.3	5,960	9.68	8.80	50.02	0.18	12.37	40.98	13.82	1.64		4,639	306	43.6
					14	13	73	0	18	60	20	2				
	05/12/92	16.0	7.3	7,139	204	101	1,150	-	-	-	-	78	3.0	4,430	925	16.4
	0845	60.8	-	5,820	10.18	8.30	50.02	-	-	-	-	1.26		-	-	-
					-	-	-	-	-	-	-	-				
ERR 8429	01/14/92	17.0	8.0	3,658	31	29	803	-	-	-	-	78	2.5	2,530	197	24.9
	1115	62.6	-	3,720	1.55	2.38	34.93	-	-	-	-	1.26		-	-	-
					-	-	-	-	-	-	-	-				
	03/10/92	17.0	7.8	5,900	65	58	1,260	4	802	1,440	598	67	3.0	4,100	401	27.3
	1115	62.6	8.3	5,860	3.24	4.77	54.81	0.10	16.03	29.95	16.86	1.08		4,294	0	63.1
					5	8	87	0	25	47	26	2				
	05/12/92	17.0	7.9	4,944	60	48	971	-	-	-	-	92	2.2	3,120	347	22.6
	0900	62.6	-	4,530	2.99	3.95	42.24	-	-	-	-	1.48		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	22.0	7.5	3,578	55	43	728	-	-	-	-	62	1.7	2,460	314	17.8
	1000	71.6	-	3,620	2.74	3.53	31.67	-	-	-	-	1.00		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field / Laboratory pH	EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
ERR 8429	11/06/92	22.0	7.8	3,922	37	35	806	-	-	-	-	78	2.7	2,660	237	22.8
	1000	71.6	-	3,850	1.85	2.88	35.06	-	-	-	-	1.26		-	-	-
					-	-	-	-	-	-	-	-				
ERR 8641	03/10/92	17.0	7.3	26,255	406	709	6,040	37	746	12,200	2,600	66	6.3	23,300	3,930	41.8
	1130	62.6	7.9	24,400	20.26	58.28	262.74	0.95	14.91	253.76	73.32	1.06		22,804	3,184	116.9
					6	17	77	0	4	74	21	0				
	05/12/92	16.0	7.3	22,082	326	536	4,650	-	-	-	-	47	4.8	17,600	3,020	36.8
	0930	60.8	-	19,700	16.27	44.06	202.27	-	-	-	-	0.76		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	20.0	7.1	20,812	316	584	5,980	-	-	-	-	56	4.8	19,000	3,190	46.0
	1015	68.0	-	20,600	15.77	48.00	260.13	-	-	-	-	0.90		-	-	-
					-	-	-	-	-	-	-	-				
	11/06/92	20.0	7.3	12,210	198	307	2,620	-	-	-	-	24	3.2	10,100	1,760	27.1
	1015	68.0	-	12,100	9.88	25.24	113.97	-	-	-	-	0.39		-	-	-
					-	-	-	-	-	-	-	-				
GSY 0855	03/10/92	17.0	7.1	12,980	482	294	2,500	21	436	5,980	915	67	3.7	10,900	2,410	22.1
	1200	62.6	7.8	12,200	24.05	24.17	108.75	0.54	8.71	124.38	25.80	1.08		-	1,974	63.3
					15	15	69	0	5	78	16	1				
HCH 7439	03/10/92	16.0	8.3	5,808	72	62	1,120	4	345	1,600	584	1	2.5	3,770	435	23.3
	0945	60.8	8.3	5,380	3.59	5.10	48.72	0.09	6.90	33.28	16.47	0.02		-	90	-
					6	9	85	0	12	59	29	0				
	05/12/92	15.0	8.3	4,328	41	40	788	-	-	-	-	0	2.7	2,650	267	20.9
	0700	59.0	-	3,960	2.05	3.29	34.28	-	-	-	-	0.01		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	19.0	8.1	3,164	39	32	652	-	-	-	-	0	2.0	2,210	229	18.7
	0845	66.2	-	3,290	1.95	2.63	28.36	-	-	-	-	0.01		-	-	-
					-	-	-	-	-	-	-	-				
	09/11/92	19.0	8.1	4,158	36	32	743	-	-	-	-	0	2.4	2,530	222	21.7
	0800	66.2	-	3,740	1.80	2.63	32.32	-	-	-	-	0.00		-	-	-
					-	-	-	-	-	-	-	-				
	11/06/92	20.0	8.5	2,803	34	28	566	-	-	-	-	1	2.0	1,920	200	17.4
	0845	68.0	-	2,870	1.70	2.30	24.62	-	-	-	-	0.01		-	-	-
					-	-	-	-	-	-	-	-				
LNW 5454	07/06/92	22.0	7.8	26,394	501	298	7,140	-	-	-	-	143	52.0	22,600	2,480	62.3
	1000	71.6	-	26,600	25.00	24.50	310.59	-	-	-	-	2.30		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	Field Laboratory EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
LNW 5454	11/05/92	21.0	7.3	20,200	494	246	4,810	-	-	-	-	79	38.0	18,300	2,250	44.1
	1100	69.8	-	21,600	24.65	20.22	209.23	-	-	-	-	1.27		-	-	-
					-	-	-	-	-	-	-	-				
LNW 5467	01/13/92	17.0	7.6	11,800	582	153	2,320	-	-	-	-	278	19.0	9,720	2,080	22.1
	1215	62.6	-	12,100	29.04	12.58	100.92	-	-	-	-	4.48		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	17.0	7.5	-	552	189	2,770	2	143	4,620	2,250	291	20.0	11,200	2,160	25.9
	1100	62.6	7.9	13,800	27.54	15.54	120.50	0.05	2.86	96.10	63.45	4.69		-	2,017	61.2
					17	9	74	0	2	58	38	3				
	05/11/92	19.0	7.6	15,933	590	198	3,010	-	-	-	-	375	22.0	11,500	2,290	27.3
	1045	66.2	-	14,400	29.44	16.28	130.94	-	-	-	-	6.04		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	22.0	7.5	12,455	592	165	2,640	-	-	-	-	295	18.0	9,840	2,160	24.7
	0945	71.6	-	12,300	29.54	13.56	114.84	-	-	-	-	4.75		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	22.0	7.4	18,550	529	221	3,330	-	-	-	-	268	25.0	13,200	2,230	30.6
	0945	71.6	-	16,300	26.40	18.17	144.85	-	-	-	-	4.31		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	22.0	7.5	15,900	540	230	3,340	-	-	-	-	278	25.0	13,300	2,300	30.3
	1045	71.6	-	16,100	26.95	18.91	145.29	-	-	-	-	4.48		-	-	-
					-	-	-	-	-	-	-	-				
LNW 6459	01/13/92	16.0	8.1	35,695	610	417	10,300	-	-	-	-	88	33.0	32,400	3,240	78.7
	1150	60.8	-	41,300	30.44	34.28	448.05	-	-	-	-	1.42		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	18.0	7.8	-	582	358	5,600	3	169	7,100	5,650	243	38.0	20,200	2,930	45.0
	1030	64.4	7.8	25,100	29.04	29.43	243.60	0.08	3.38	147.68	159.33	3.91		-	2,761	110.7
					10	10	81	0	1	47	51	1				
	05/11/92	15.0	7.9	55,430	622	491	13,200	-	-	-	-	162	47.0	42,200	3,580	96.0
	1000	59.0	-	50,800	31.04	40.36	574.20	-	-	-	-	2.61		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	18.0	7.8	55,200	642	535	13,600	-	-	-	-	144	47.0	43,300	3,810	95.9
	0915	64.4	-	51,900	32.04	43.98	591.60	-	-	-	-	2.32		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	21.0	8.0	73,440	494	462	17,200	-	-	-	-	133	45.0	42,600	3,140	133.6
	0930	69.8	-	51,500	24.65	37.98	748.20	-	-	-	-	2.14		-	-	-
					-	-	-	-	-	-	-	-				

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field / Laboratory pH	EC (µS/cm)	Mineral Constituents in : Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
LNW 6459	11/05/92	20.0	7.6	57,720	663	557	17,000	-	-	-	-	140	46.0	46,200	3,950	117.6
	1015	68.0	-	54,400	33.08	45.79	739.50	-	-	-	-	2.25		-	-	-
					-	-	-	-	-	-	-	-				
LNW 6467	01/13/92	17.0	7.8	19,765	624	312	4,040	-	-	-	-	197	27.0	15,300	2,840	32.9
	1200	62.6	-	19,400	31.14	25.65	175.74	-	-	-	-	3.17		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	17.0	7.6	-	588	387	6,120	3	169	7,270	5,850	262	39.0	21,100	3,060	48.1
	1045	62.6	7.8	25,900	29.34	31.81	266.22	0.07	3.38	151.22	164.97	4.22		-	2,891	118.3
					9	10	81	0	1	47	51	1				
	05/11/92	17.0	7.9	28,615	594	352	7,680	-	-	-	-	252	43.0	21,100	2,930	61.6
	1020	62.6	-	25,500	29.64	28.93	334.08	-	-	-	-	4.06		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	22.0	7.5	12,455	532	368	6,580	-	-	-	-	234	48.0	22,800	2,840	53.6
	0930	71.6	-	27,000	26.55	30.25	286.23	-	-	-	-	3.77		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	22.0	7.3	11,448	630	302	3,580	-	-	-	-	192	27.0	15,100	2,820	29.3
	1030	71.6	-	18,900	31.44	24.82	155.73	-	-	-	-	3.09		-	-	-
					-	-	-	-	-	-	-	-				
SFD 2727	03/10/92	17.0	7.0	7,965	296	448	1,240	3	373	3,980	325	67	2.7	7,010	2,580	10.6
	1215	62.6	8.0	7,470	14.77	36.83	53.94	0.09	7.46	82.78	9.17	1.08		6,732	2,207	27.0
					14	35	51	0	7	82	9	1				
	05/12/92	17.0	7.1	8,555	286	452	1,260	-	-	-	-	63	2.5	7,050	2,580	10.8
	1000	62.6	-	7,630	14.27	37.15	54.81	-	-	-	-	1.01		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	24.0	6.8	4,182	189	230	649	-	-	-	-	62	1.5	3,680	1,420	7.4
	1045	75.2	-	4,450	9.43	18.91	28.23	-	-	-	-	1.00		-	-	-
					-	-	-	-	-	-	-	-				
	09/11/92	20.0	6.9	7,326	218	157	556	-	-	-	-	4	1.3	3,250	1,190	7.0
	1000	68.0	-	3,930	10.88	12.91	24.19	-	-	-	-	0.06		-	-	-
					-	-	-	-	-	-	-	-				
STC 3505	01/14/92	15.0	8.0	2,976	59	9	614	-	-	-	-	76	2.2	1,970	184	19.6
	0815	59.0	-	3,000	2.94	0.74	26.71	-	-	-	-	1.22		-	-	-
					-	-	-	-	-	-	-	-				
	03/10/92	17.0	7.5	3,068	66	10	571	1	330	550	339	83	1.5	1,890	206	17.3
	0830	62.6	8.1	2,920	3.29	0.82	24.84	0.01	6.60	11.44	9.56	1.34		-	0	39.8
					11	3	86	0	23	40	33	5				

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter B	TDS Sum	TH NCH	SAR ASAR as CaCO3
STC 3505	05/12/92	15.0	8.0	3,348	55	7	580	-	-	-	-	96	1.6	1,860	166	19.5
	0530	59.0	-	2,890	2.74	0.58	25.23	-	-	-	-	1.55		-	-	-
					-	-	-	-	-	-	-	-				
	07/07/92	22.0	7.8	2,639	48	7	554	-	-	-	-	95	1.6	1,770	149	19.7
	0800	71.6	-	2,740	2.40	0.58	24.10	-	-	-	-	1.53		-	-	-
					-	-	-	-	-	-	-	-				
	09/11/92	22.0	8.0	2,968	41	6	543	-	-	-	-	90	1.6	1,750	127	20.9
	0700	71.6	-	2,700	2.05	0.49	23.62	-	-	-	-	1.45		-	-	-
					-	-	-	-	-	-	-	-				
	11/06/92	21.0	8.1	2,711	48	7	589	-	-	-	-	87	1.6	1,830	149	21.0
	0745	69.8	-	2,810	2.40	0.58	25.62	-	-	-	-	1.40		-	-	-
					-	-	-	-	-	-	-	-				
STC 5436	03/10/92	16.0	8.0	12,705	106	60	2,770	8	493	2,800	2,180	64	9.1	8,420	512	53.2
	0900	60.8	8.3	11,900	5.29	4.93	120.50	0.21	9.85	58.24	61.48	1.03		-	19	141.6
					4	4	92	0	8	45	47	1				
VGD 3906	03/09/92	17.0	7.6	-	322	715	6,810	5	361	15,500	1,350	53	37.0	26,000	3,750	48.3
	0930	62.6	8.0	25,400	16.07	58.77	296.23	0.14	7.22	322.40	38.07	0.85		-	3,389	133.5
					4	16	80	0	2	87	10	0				
	05/11/92	17.0	7.1	32,922	424	998	7,850	-	-	-	-	33	33.0	30,900	5,170	47.5
	0845	62.6	-	29,600	21.16	82.04	341.47	-	-	-	-	0.53		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	19.0	7.5	27,120	286	1,050	8,770	-	-	-	-	41	33.0	27,700	5,040	53.7
	0800	66.2	-	26,800	14.27	86.31	381.49	-	-	-	-	0.66		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	19.0	7.4	33,335	246	755	7,020	-	-	-	-	37	34.0	28,600	3,720	50.0
	0815	66.2	-	27,400	12.28	62.06	305.37	-	-	-	-	0.60		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	19.0	7.5	27,685	322	889	6,850	-	-	-	-	33	30.0	28,000	4,460	44.6
	0900	66.2	-	26,800	16.07	73.08	297.97	-	-	-	-	0.53		-	-	-
					-	-	-	-	-	-	-	-				
VGD 4406	01/13/92	16.0	7.9	25,712	388	820	7,230	-	-	-	-	45	40.0	28,300	4,350	47.7
	0930	60.8	-	27,200	19.36	67.40	314.50	-	-	-	-	0.72		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	17.0	7.6	-	302	808	7,310	6	394	16,800	1,540	41	37.0	28,300	4,080	49.7
	0900	62.6	8.0	27,200	15.07	66.42	317.98	0.15	7.88	349.44	43.43	0.66		-	3,686	137.4
					4	17	80	0	2	87	11	0				

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The agricultural water user generally will find the total dissolved solids (TDS) values more useful for drainage needs than the sodium and sulfate values. As TDS rises in drainage water, soil EC also tends to rise. With higher soil EC, soil permeability is reduced, requiring the agricultural user to apply soil amendments like gypsum to maintain permeability. TDS is approximately 0.8 times the EC, as chronicled in the drainage monitoring report for 1974. Table 7 summarizes TDS averages from 1986 through 1992 for the central and southern areas. In the central and southern areas, the 1992 TDS readings were slightly lower than past averages, which could signify a change in ground water characteristics. Continual monitoring will be required to confirm this speculation. In the southern area, TDS values exceeding 40,000 mg/L occurred only at stations LNW 6459 and VGD 4406, with most other stations well under 30,000 mg/L.

TABLE 7

TOTAL DISSOLVED SOLIDS IN SUBSURFACE DRAINS
1986 THROUGH 1992
(milligrams per liter)

Area	Arithmetic Average / Geometric Mean							1992	
	1986	1987	1988	1989	1990	1991	1992	Minimum	Maximum
Central	5,898 5,391	6,216 5,603	5,584 5,021	5,461 4,918	5,497 5,000	5,754 5,386	5,211 4,633	1,860	11,500
Southern	13,708 8,934	17,249 12,000	14,408 9,423	13,318 8,778	14,008 9,278	13,554 8,895	13,859 8,738	1,750	46,200

Increasing attention is being given to reuse of agricultural drainage water. Ideal irrigation water would have less than 450 mg/L of TDS. Drainage water reapplied to most crops should have an EC of less than 3,000 µS/cm, although some crops like deciduous fruit trees have a much lower EC tolerance. Also, if drainage water high in sodium and other salts is reused as irrigation water without treatment or dilution, permeability problems may develop in the soil. High levels of sodium in combination with chloride in irrigation water can lead to crop tissue burns if such water is applied during germination.

The sodium adsorption ratio (SAR) of water reflects water's ability to enter into cation-exchange reactions within the soil. High SAR values imply that sodium will replace the more beneficial calcium and magnesium ions in the soil structure. As an index of the danger of adverse sodium effects, the allowable SAR for fruit crops may be as low as 4 or as high as 16 for some tolerant field crops. The central area had a maximum SAR value of 20.5, with an average SAR value of 9.71 in its subsurface drains. The southern area subsurface drains had a maximum of 133.6 at station LNW 6459 during September 1992. Station LNW 6459 also had a high SAR value of 117.6 in November 1992. The average SAR value for the southern area was 32.4.

TABLE 6 (continued)

MINERAL ANALYSES OF SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date / Time	Temp. °C / °F	Field Laboratory pH	Field Laboratory EC (µS/cm)	Mineral Constituents in: Milligrams per Liter / Milliequivalents per Liter / Percent Reactance Value — Ca	Mg	Na	K	T. Alk. as CaCO3	SO4	Cl	NO3	Mineral Constituents in Milligrams per Liter — B	TDS / Sum	TH / NCH	SAR / ASAR as CaCO3
VGD 4406	05/11/92	16.0	7.5	32,670	430	943	7,770	-	-	-	-	35	36.0	30,700	4,960	48.0
	0815	60.8	-	29,200	21.46	77.51	337.99	-	-	-	-	0.56		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	19.0	7.5	24,860	386	693	7,350	-	-	-	-	48	34.0	24,500	3,820	51.7
	0745	66.2	-	24,100	19.26	56.96	319.72	-	-	-	-	0.77		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	20.0	7.5	35,520	353	1,170	8,280	-	-	-	-	31	36.0	33,800	5,700	47.7
	0800	68.0	-	31,300	17.61	96.17	360.18	-	-	-	-	0.50		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	19.0	7.9	38,646	318	1,490	14,900	-	-	-	-	18	39.0	42,800	6,930	77.8
	0845	66.2	-	37,600	15.87	22.48	548.15	-	-	-	-	0.29		-	-	-
					-	-	-	-	-	-	-	-				
VGD 5412	01/13/92	17.0	7.4	18,880	372	746	5,050	-	-	-	-	17	22.0	21,000	4,000	34.7
	0900	62.6	-	21,100	18.56	61.32	219.68	-	-	-	-	0.27		-	-	-
					-	-	-	-	-	-	-	-				
	03/09/92	17.0	7.3	-	366	475	4,900	9	433	11,800	1,110	23	26.0	19,800	2,870	39.7
	0830	62.6	8.0	20,100	18.26	39.04	213.15	0.22	8.65	245.44	31.30	0.37		-	2,437	113.8
					7	14	79	0	3	86	11	0				
	05/11/92	16.0	7.3	23,292	380	624	5,220	-	-	-	-	24	28.0	20,300	3,520	38.2
	0745	60.8	-	20,700	18.96	51.29	227.07	-	-	-	-	0.39		-	-	-
					-	-	-	-	-	-	-	-				
	07/06/92	18.0	7.4	20,585	652	1,380	6,530	-	-	-	-	25	25.0	21,100	7,310	33.2
	0730	64.4	-	21,300	32.53	13.44	284.06	-	-	-	-	0.40		-	-	-
					-	-	-	-	-	-	-	-				
	09/10/92	20.0	7.6	26,418	405	751	5,740	-	-	-	-	25	26.0	23,700	4,100	38.9
	0745	68.0	-	23,300	20.21	61.73	249.69	-	-	-	-	0.40		-	-	-
					-	-	-	-	-	-	-	-				
	11/05/92	19.0	7.3	23,165	407	938	5,200	-	-	-	-	20	23.0	24,400	4,880	32.3
	0830	66.2	-	23,700	20.31	77.10	226.20	-	-	-	-	0.32		-	-	-
					-	-	-	-	-	-	-	-				

The adjusted sodium adsorption ratio (ASAR) takes into account the additional effects of carbonate and bicarbonate in increasing a soil's sodium level. Bicarbonate ions in water cause calcium to be precipitated as calcium carbonate while not affecting the sodium in solution. For the central area, the maximum ASAR was 51.9 with an average value of 27.9 in its subsurface drains. In the southern area, the maximum ASAR was 141.6 at Station STC 5436 in March 1992. The average ASAR in the southern area was 80.9.

Boron, an essential mineral in small quantities for plant growth, often occurs at unacceptable levels in drain waters. Excessive quantities of boron in irrigation water can be toxic to some plants. The central area drains had a maximum boron concentration of 60.0 mg/L, but the average was only 14.1 mg/L for its subsurface drains. Similar readings were found in the southern area with a maximum boron level of 52.0 mg/L and an average 16.9 mg/L. In both the central and southern areas, the maximum levels and overall area averages for boron have remained fairly constant.

Total hardness (as calcium carbonate) was lowest in the central area with a maximum level of 3,150 mg/L and a subsurface drain average of 1,775 mg/L. The southern area had higher overall concentrations with a maximum of 7,310 mg/L and an average of 2,296 mg/L. Water with greater than 300-mg/L hardness levels can cause scaling in irrigation and drainage pipes if the water becomes warm.

Effluent at the two surface drainage stations (CTL 4504 and DPS 3235) had sodium, sulfate, and chloride as its principal mineral constituents. Since surface drains can contain a mixture of tail water, subsurface drain water, and other runoff, the mineral levels will be lower due to dilution. EC had a maximum level of 5,180 µS/cm and an average of 4,765 µS/cm for the two stations. Boron averaged 8.1 mg/L and had a maximum reading of 9.6 mg/L. The SAR averaged 8.2 with an average ASAR of 21.2.

Trace Elements

Because their 1987 concentrations were very low or undetectable, the following trace elements have not been sampled for since that year: aluminum, barium, cadmium, cobalt, copper, iron, lead, mercury, silver, and zinc. As new sampling locations are established, these elements will be sampled for on an occasional basis until a thorough water quality history is established.

Trace elements sampled for in 1992 included arsenic, chromium, manganese, molybdenum, nickel, selenium, and strontium. These elements and others are considered trace elements because they occur in smaller concentrations than do mineral elements.

In 1992, DWR analyzed 44 samples from the central subsurface drains, 12 samples from the central surface drains, and 87 samples from the southern subsurface drains. Trace elements detected in the central subsurface and surface drains and southern subsurface drains are summarized in Table 8. The monthly values for all sampled stations can be found in Tables 9 and 10 for the central subsurface and surface drains and southern subsurface drains, respectively.

TABLE 8

SUMMARY OF TRACE ELEMENTS DETECTED
1992

Element	Times Sampled	Times Detected	Percentage of Times Detected	Concentration (milligrams per liter)			
				Maximum	Minimum	Arithmetic Average	Geometric Mean
Central Area Surface Drains							
Arsenic	2	2	100	0.002	0.001	0.002	0.001
Chromium	2	2	100	0.029	0.017	0.023	0.022
Manganese	2	2	100	0.082	0.073	0.077	0.077
Molybdenum	2	2	100	0.023	0.009	0.016	0.014
Nickel	2	0	0	0.000	0.000	0.000	0.000
Selenium	12	12	100	0.107	0.044	0.078	0.075
Strontium	2	2	100	5.200	4.400	4.800	4.783
Central Area Subsurface Drains							
Arsenic	9	9	100	0.002	0.001	0.001	0.001
Chromium	9	8	89	0.100	0.008	0.042	0.031
Manganese	9	3	33	0.177	0.009	0.071	0.035
Molybdenum	9	6	67	0.134	0.007	0.062	0.045
Nickel	9	1	11	0.007	0.007	0.007	0.007
Selenium	44	44	100	0.250	0.002	0.066	0.042
Strontium	9	9	100	11.000	3.100	5.760	5.161
Southern Area Subsurface Drains							
Arsenic	16	16	100	0.490	0.002	0.079	0.022
Chromium	16	4	25	0.013	0.010	0.011	0.011
Manganese	16	12	75	2.600	0.008	0.532	0.181
Molybdenum	16	16	100	1.200	0.106	0.590	0.453
Nickel	9	5	56	0.017	0.006	0.010	0.009
Selenium	87	87	100	0.900	0.001	0.075	0.012
Strontium	16	16	100	11.000	0.600	4.730	3.378

TABLE 9

TRACE ELEMENTS DETECTED IN CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date	Lab EC (µS/cm)	Field pH	Trace Elements (milligrams per liter)						
				As	Total Cr	Mn	Mo	Ni	Se	Sr
BVS 6016	01/14/92	6,420	7.6	-	-	-	-	-	0.085	-
	03/11/92	4,860	7.6	0.001	0.020	<0.005	0.043	<0.005	0.068	3.60
	05/13/92	5,680	7.3	-	-	-	-	-	0.074	-
	07/08/92	5,760	6.7	-	-	-	-	-	0.082	-
BVS 8003	01/14/92	8,570	7.5	-	-	-	-	-	0.132	-
	03/11/92	8,610	7.3	0.002	0.018	<0.005	0.134	0.007	0.200	4.20
	07/08/92	11,300	7.4	-	-	-	-	-	0.250	-
	09/10/92	-	7.5	-	-	-	-	-	0.218	-
	11/12/92	6,800	7.3	-	-	-	-	-	0.074	-
CTL 4504	01/14/92	4,880	8.0	-	-	-	-	-	0.077	-
	03/11/92	5,050	8.3	0.001	0.017	0.073	0.023	<0.005	0.090	4.40
	05/13/92	4,000	8.4	-	-	-	-	-	0.061	-
	07/08/92	4,440	8.3	-	-	-	-	-	0.072	-
	09/10/92	-	8.3	-	-	-	-	-	0.075	-
	11/12/92	4,340	7.9	-	-	-	-	-	0.044	-
DPS 1367	01/14/92	5,370	7.3	-	-	-	-	-	0.140	-
	03/11/92	5,300	7.4	0.001	0.025	<0.005	<0.005	<0.005	0.138	6.60
	05/13/92	5,210	7.4	-	-	-	-	-	0.104	-
	07/08/92	5,450	7.4	-	-	-	-	-	0.141	-
	09/10/92	-	7.3	-	-	-	-	-	0.140	-
	11/12/92	5,490	7.4	-	-	-	-	-	0.133	-
DPS 2535	01/14/92	7,870	7.3	-	-	-	-	-	0.032	-
	03/11/92	8,170	7.2	0.001	0.100	<0.005	0.007	<0.005	0.031	9.60
	05/13/92	8,690	7.4	-	-	-	-	-	0.033	-
	07/08/92	9,190	7.3	-	-	-	-	-	0.038	-
	09/10/92	-	7.3	-	-	-	-	-	0.050	-
	11/12/92	12,300	7.2	-	-	-	-	-	0.058	-
DPS 3235	01/14/92	4,850	8.0	-	-	-	-	-	0.080	-
	03/11/92	5,180	8.0	0.002	0.029	0.082	0.009	<0.005	0.091	5.20
	05/13/92	5,100	8.4	-	-	-	-	-	0.082	-
	07/08/92	4,790		-	-	-	-	-	0.107	-
	09/10/92	-	8.4	-	-	-	-	-	0.083	-
	11/12/92	5,020	8.4	-	-	-	-	-	0.061	-
DPS 3465	01/14/92	7,110	7.0	-	-	-	-	-	0.018	-
	03/11/92	7,660	7.0	0.001	0.064	0.177	<0.005	<0.005	0.023	11.00
	05/13/92	6,350	7.2	-	-	-	-	-	0.015	-
	07/08/92	7,050	7.1	-	-	-	-	-	0.017	-
	11/12/92	6,810	7.0	-	-	-	-	-	0.022	-
DPS 4616	01/14/92	10,700	7.3	-	-	-	-	-	0.008	-

TABLE 9 (continued)

TRACE ELEMENTS DETECTED IN CENTRAL AREA SUBSURFACE AND SURFACE DRAINS
1992

Station	Date	Lab EC (µS/cm)	Field pH	Trace Elements (milligrams per liter)						
				As	Total Cr	Mn	Mo	Ni	Se	Sr
DPS 4616	03/11/92	13,000	7.4	0.002	0.030	0.026	0.038	<0.005	0.018	6.90
	11/12/92	12,400	7.3	-	-	-	-	-	0.016	-
FBH 2016	01/14/92	6,980	8.0	-	-	-	-	-	0.134	-
	03/11/92	3,100	7.4	0.002	<0.005	0.009	0.065	<0.005	0.036	3.10
FBH 8061	01/14/92	2,310	7.6	-	-	-	-	-	0.002	-
	03/11/92	2,730	7.4	0.002	0.008	<0.005	0.082	<0.005	0.009	3.20
	05/13/92	5,140	7.5	-	-	-	-	-	0.036	-
	07/08/92	5,400	7.4	-	-	-	-	-	0.036	-
	09/10/92	-	7.3	-	-	-	-	-	0.016	-
	11/12/92	4,400	7.3	-	-	-	-	-	0.035	-
HMH 7516	01/14/92	3,410	6.2	-	-	-	-	-	0.030	-
	03/11/92	3,410	7.3	0.001	0.072	<0.005	<0.005	<0.005	0.032	3.60
	05/13/92	3,000	7.3	-	-	-	-	-	0.039	-
	07/08/92	2,890	7.2	-	-	-	-	-	0.017	-
	09/10/92	3,410	7.3	-	-	-	-	-	0.030	-
	11/12/92	3,310	7.3	-	-	-	-	-	0.016	-

TABLE 10

TRACE ELEMENTS DETECTED IN SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date	Lab EC (µS/cm)	Field pH	Trace Elements (milligrams per liter)						
				As	Total Cr	Mn	Mo	Ni	Se	Sr
CCN 3550	01/14/92	3,710	6.9	-	-	-	-	-	0.002	-
	03/10/92	5,720	7.3	0.013	<0.005	0.700	0.139	<0.005	0.003	2.20
	05/12/92	5,050	7.4	-	-	-	-	-	0.002	-
	07/07/92	4,250	7.1	-	-	-	-	-	0.002	-
	11/06/92	4,730	7.1	-	-	-	-	-	0.002	-
CNR 0801	01/13/92	9,070	7.8	-	-	-	-	-	0.005	-
	05/11/92	8,810	7.1	-	-	-	-	-	0.007	-
	07/06/92	6,030	7.4	-	-	-	-	-	0.007	-
	09/10/92	-	7.0	-	-	-	-	-	0.002	-
	11/05/92	2,490	7.6	-	-	-	-	-	0.004	-
COC 4126	01/13/92	5,180	7.4	-	-	-	-	-	0.022	-
	03/09/92	5,270	7.3	0.002	<0.005	0.023	0.116	<0.005	0.020	5.00
	05/11/92	5,450	7.3	-	-	-	-	-	0.020	-
	07/06/92	5,150	7.5	-	-	-	-	-	0.018	-
	09/10/92	-	7.1	-	-	-	-	-	0.016	-
	11/05/92	5,100	7.5	-	-	-	-	-	0.014	-
COC 5329	01/13/92	7,920	7.0	-	-	-	-	-	0.396	-
	07/06/92	7,530	7.5	-	-	-	-	-	0.372	-
	09/10/92	-	7.3	-	-	-	-	-	0.282	-
	11/05/92	7,080	7.3	-	-	-	-	-	0.328	-
ERR 7525	01/14/92	5,050	7.5	-	-	-	-	-	0.007	-
	03/10/92	5,960	7.5	0.091	0.010	0.127	0.368	0.006	0.006	1.60
	05/12/92	5,820	7.3	-	-	-	-	-	0.006	-
ERR 8429	01/14/92	3,720	8.0	-	-	-	-	-	0.004	-
	03/10/92	5,860	7.8	0.149	<0.005	0.134	0.420	0.007	0.004	0.70
	05/12/92	4,530	7.9	-	-	-	-	-	0.003	-
	07/07/92	3,620	7.5	-	-	-	-	-	0.003	-
	09/11/92	-	7.9	-	-	-	-	-	0.004	-
	11/06/92	3,850	7.8	-	-	-	-	-	0.005	-
ERR 8641	03/10/92	24,400	7.3	0.039	<0.005	2.600	1.200	0.017	0.030	4.70
	05/12/92	19,700	7.3	-	-	-	-	-	0.020	-
	07/07/92	20,600	7.1	-	-	-	-	-	0.024	-
	09/11/92	-	7.3	-	-	-	-	-	0.015	-
	11/06/92	12,100	7.3	-	-	-	-	-	0.008	-
GSY 0855	03/10/92	12,200	7.1	0.060	<0.005	0.182	0.705	0.011	0.026	3.40
HCH 7439	03/10/92	5,380	8.3	0.240	<0.005	<0.005	0.940	<0.005	0.003	1.40
	05/12/92	3,960	8.3	-	-	-	-	-	0.005	-
	07/07/92	3,290	8.1	-	-	-	-	-	0.001	-
	09/11/92	3,740	8.1	-	-	-	-	-	0.001	-
	11/06/92	2,870	8.5	-	-	-	-	-	0.001	-

TABLE 10 (continued)

TRACE ELEMENTS DETECTED IN SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date	Lab EC (µS/cm)	Field pH	Trace Elements (milligrams per liter)						
				As	Total Cr	Mn	Mo	Ni	Se	Sr
LNW 5454	07/06/92	26,600	7.8	-	-	-	-	-	0.182	-
	11/05/92	21,600	7.3	-	-	-	-	-	0.009	-
LNW 5467	01/13/92	12,100	7.6	-	-	-	-	-	0.164	-
	03/09/92	13,800	7.5	0.003	<0.005	<0.005	0.564	<0.005	0.194	8.90
	05/11/92	14,400	7.6	-	-	-	-	-	0.196	-
	07/06/92	12,300	7.5	-	-	-	-	-	0.177	-
	09/10/92	16,300	7.4	-	-	-	-	-	0.220	-
	11/05/92	16,100	7.5	-	-	-	-	-	0.227	-
LNW 6459	01/13/92	41,300	8.1	-	-	-	-	-	0.059	-
	03/09/92	25,100	7.8	0.004	0.011	0.008	0.855	-	0.412	11.00
	05/11/92	50,800	7.9	-	-	-	-	-	0.102	-
	07/06/92	51,900	7.8	-	-	-	-	-	0.077	-
	09/10/92	51,500	8.0	-	-	-	-	-	0.076	-
	11/05/92	54,400	7.6	-	-	-	-	-	0.084	-
LNW 6467	01/13/92	19,400	7.8	-	-	-	-	-	0.245	-
	03/09/92	25,900	7.6	0.003	0.010	<0.005	0.940	-	0.900	11.00
	05/11/92	25,500	7.9	-	-	-	-	-	0.577	-
	07/06/92	27,000	7.5	-	-	-	-	-	0.620	-
	11/05/92	18,900	7.3	-	-	-	-	-	0.230	-
SFD 2727	03/10/92	7,470	7.0	0.031	<0.005	0.068	0.130	0.008	0.002	2.00
	05/12/92	7,630	7.1	-	-	-	-	-	0.003	-
	07/07/92	4,450	6.8	-	-	-	-	-	0.002	-
	09/11/92	3,930	6.9	-	-	-	-	-	0.001	-
STC 3505	01/14/92	3,000	8.0	-	-	-	-	-	0.005	-
	03/10/92	2,920	7.5	0.113	<0.005	<0.005	0.106	-	0.004	0.60
	05/12/92	2,890	8.0	-	-	-	-	-	0.004	-
	07/07/92	2,740	7.8	-	-	-	-	-	0.004	-
	09/11/92	2,700	8.0	-	-	-	-	-	0.004	-
	11/06/92	2,810	8.1	-	-	-	-	-	0.004	-
STC 5436	03/10/92	11,900	8.0	0.490	<0.005	0.060	0.925	-	0.001	2.60
VGD 3906	03/09/92	25,400	7.6	0.007	0.013	0.328	0.772	-	0.007	7.30
	05/11/92	29,600	7.1	-	-	-	-	-	0.010	-
	07/06/92	26,800	7.5	-	-	-	-	-	0.005	-
	09/10/92	27,400	7.4	-	-	-	-	-	0.006	-
	11/05/92	26,800	7.5	-	-	-	-	-	0.004	-
VGD 4406	01/13/92	27,200	7.9	-	-	-	-	-	0.006	-
	03/09/92	27,200	7.6	0.008	<0.005	0.612	0.840	-	0.005	7.60
	05/11/92	29,200	7.5	-	-	-	-	-	0.004	-
	07/06/92	24,100	7.5	-	-	-	-	-	0.004	-

TABLE 10 (continued)

TRACE ELEMENTS DETECTED IN SOUTHERN AREA SUBSURFACE DRAINS
1992

Station	Date	Lab EC (µS/cm)	Field pH	Trace Elements (milligrams per liter)						
				As	Total Cr	Mn	Mo	Ni	Se	Sr
VGD 4406	09/10/92	31,300	7.5	-	-	-	-	-	0.005	-
	11/05/92	37,600	7.9	-	-	-	-	-	0.002	-
VGD 5412	01/13/92	21,100	7.4	-	-	-	-	-	0.002	-
	03/09/92	20,100	7.3	0.004	<0.005	1.540	0.426	-	0.002	5.60
	05/11/92	20,700	7.3	-	-	-	-	-	0.002	-
	07/06/92	21,300	7.4	-	-	-	-	-	0.002	-
	09/10/92	23,300	7.6	-	-	-	-	-	0.002	-
	11/05/92	23,700	7.3	-	-	-	-	-	0.002	-

Arsenic

Arsenic is known to occur naturally in parts of the southern drainage area, especially near the eastern edge of the Coast Range. It is also present in some insecticides and herbicides. Arsenic may cause decreased motor coordination, kidney damage, and respiratory problems in humans and livestock.

The maximum arsenic level in the central area subsurface drains for 1992 was 0.002 mg/L with an average slightly above 0.001 mg/L. Comparable arsenic levels were detected in the area's surface drains. The maximum arsenic level in the southern area subsurface drains was 0.490 mg/L at station STC 5436, near Buttonwillow Ridge. The southern area arsenic average level, however, was 0.079 mg/L — a slight decrease from the average 1991 value.

Figure 4 shows arsenic levels during 1992 for the central area stations around Firebaugh and Mendota. (Note that the bar graphs on this figure are configured to show minimal amounts of arsenic.) Figures 5 through 7 show arsenic levels for the southern area stations during 1992. Figure 5 shows arsenic levels around Lemoore and Corcoran with high readings at stations northeast of the Tulare Lake bed. The highest arsenic concentrations for the southern area were near the Semitropic and Buttonwillow Ridges, as shown on Figure 6. Figure 7 shows arsenic levels around the Kern Lake bed area.

Chromium

Chromium can cause kidney damage in human and animal life if ingested over long periods of time and can also be toxic to plants.

Chromium was detected eight times in central area subsurface drain samples with a maximum level of 0.100 mg/L and an average of 0.042 mg/L. The southern area had four chromium detections in subsurface drain samples with a maximum level of 0.013 mg/L and an average of 0.011 mg/L. The average level for chromium in 1992 was higher in the central area and slightly lower in the southern area than it was in 1991.

Manganese

Since manganese is often found in soils with significant iron levels, it should be present in most of the iron-rich drainage samples. Little is known about animal toxicity limits for manganese, but high levels of manganese can be injurious to plant and aquatic life.

Manganese levels in the central area subsurface drains in 1992 were comparable to the 1991 levels, with a maximum of 0.177 mg/L and an average of 0.071 mg/L. The central area surface drains showed detectable manganese traces in both samples taken, with an average of 0.078 mg/L and a maximum of 0.082 mg/L. Although manganese levels were as high as 2.600 mg/L in the southern area, the average for the area was only 0.532 mg/L. Peak levels for manganese in 1992 were similar to those in 1991, but the average was higher in central and southern area drains. As expected, stations VGD 3906, VGD 4406, and VGD 5412 had high manganese concentrations due to the high iron content of the soils in the area. In the Tulare Lake bed, station ERR 8641 had the highest manganese level, possibly due to the iron-rich soils.

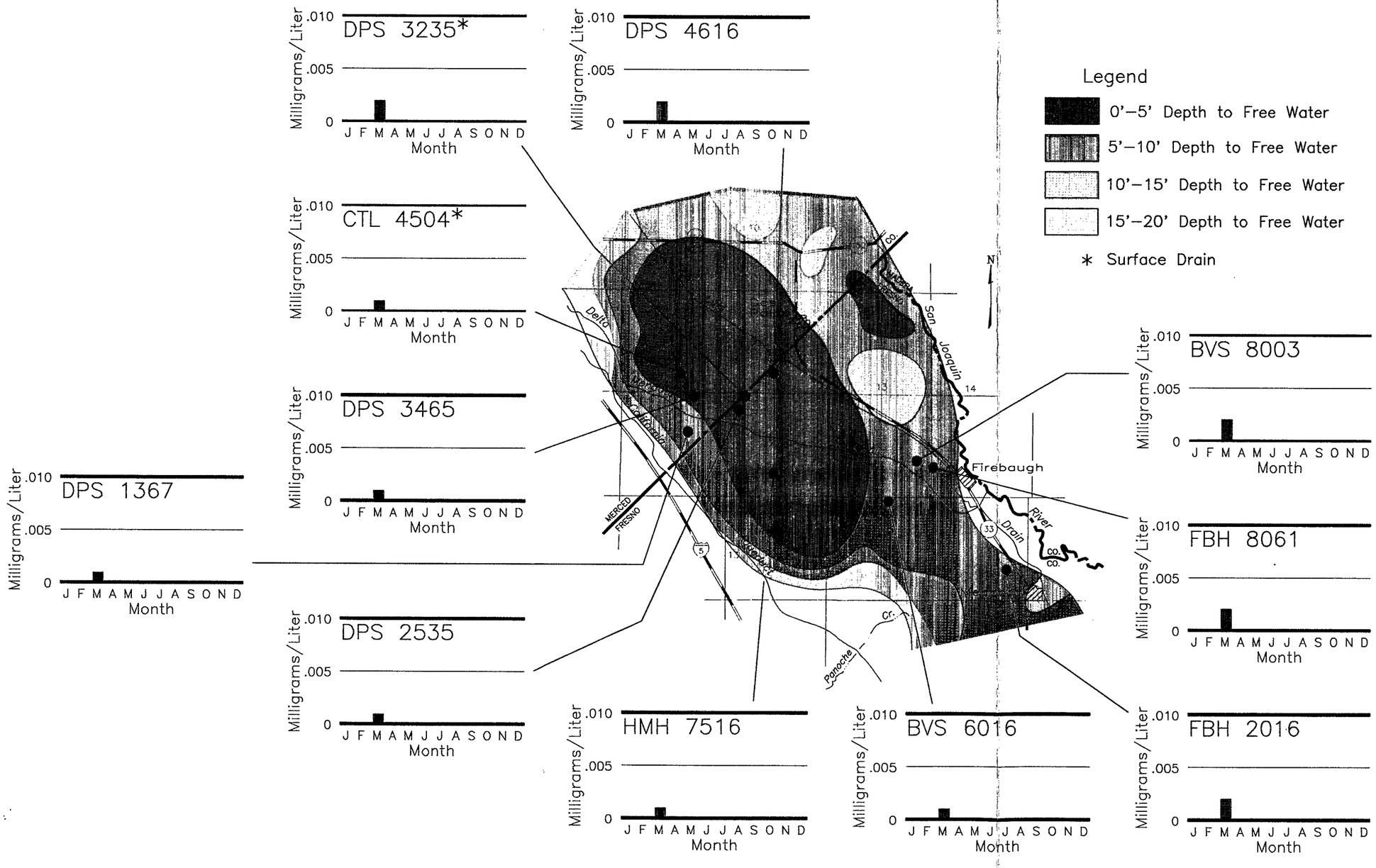


Figure 4. 1992 Arsenic Levels – Central Area, San Joaquin Valley Stations

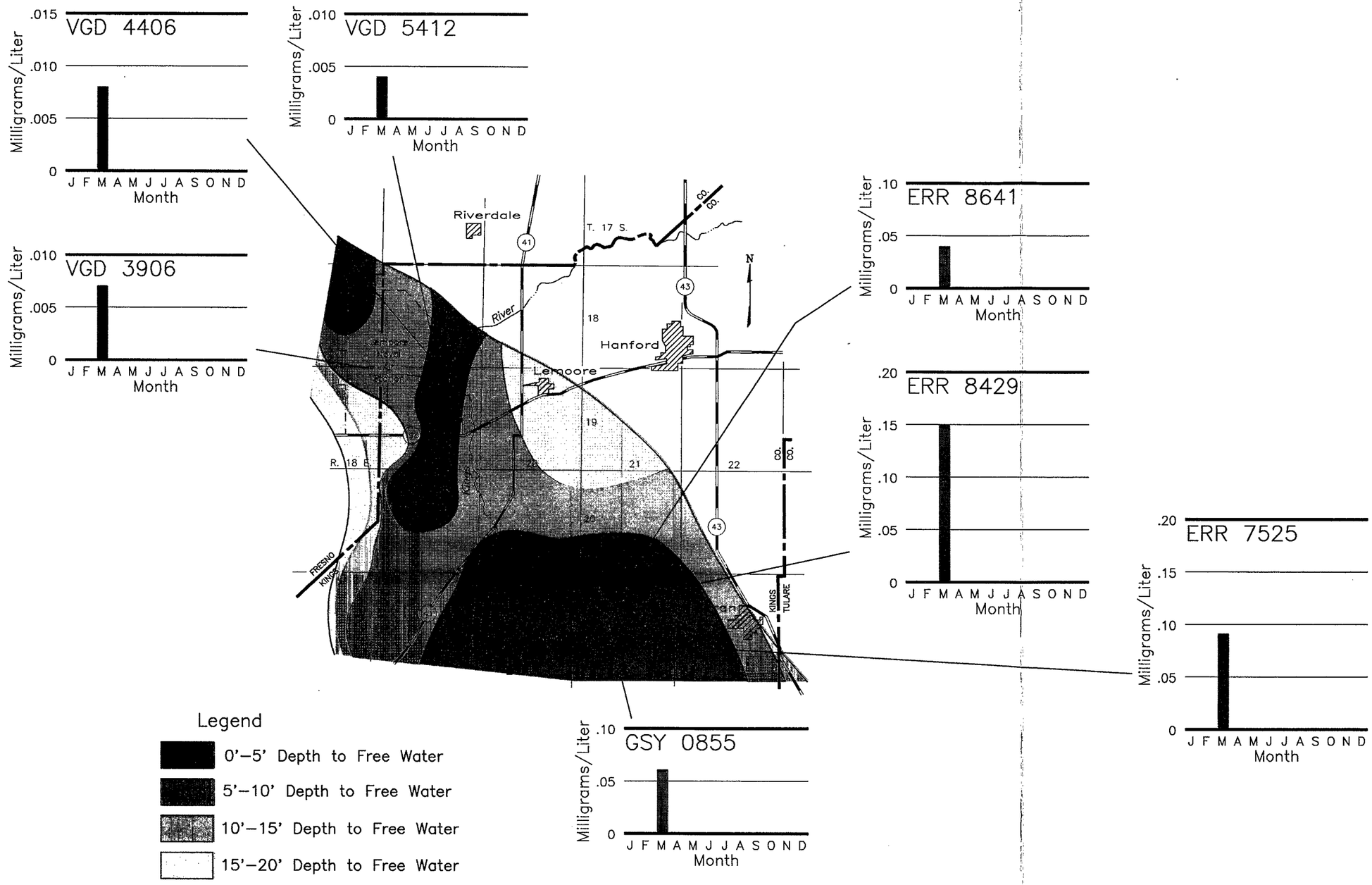


Figure 5. 1992 Arsenic Levels – Southern Area, San Joaquin Valley – Lemoore/Corcoran Stations

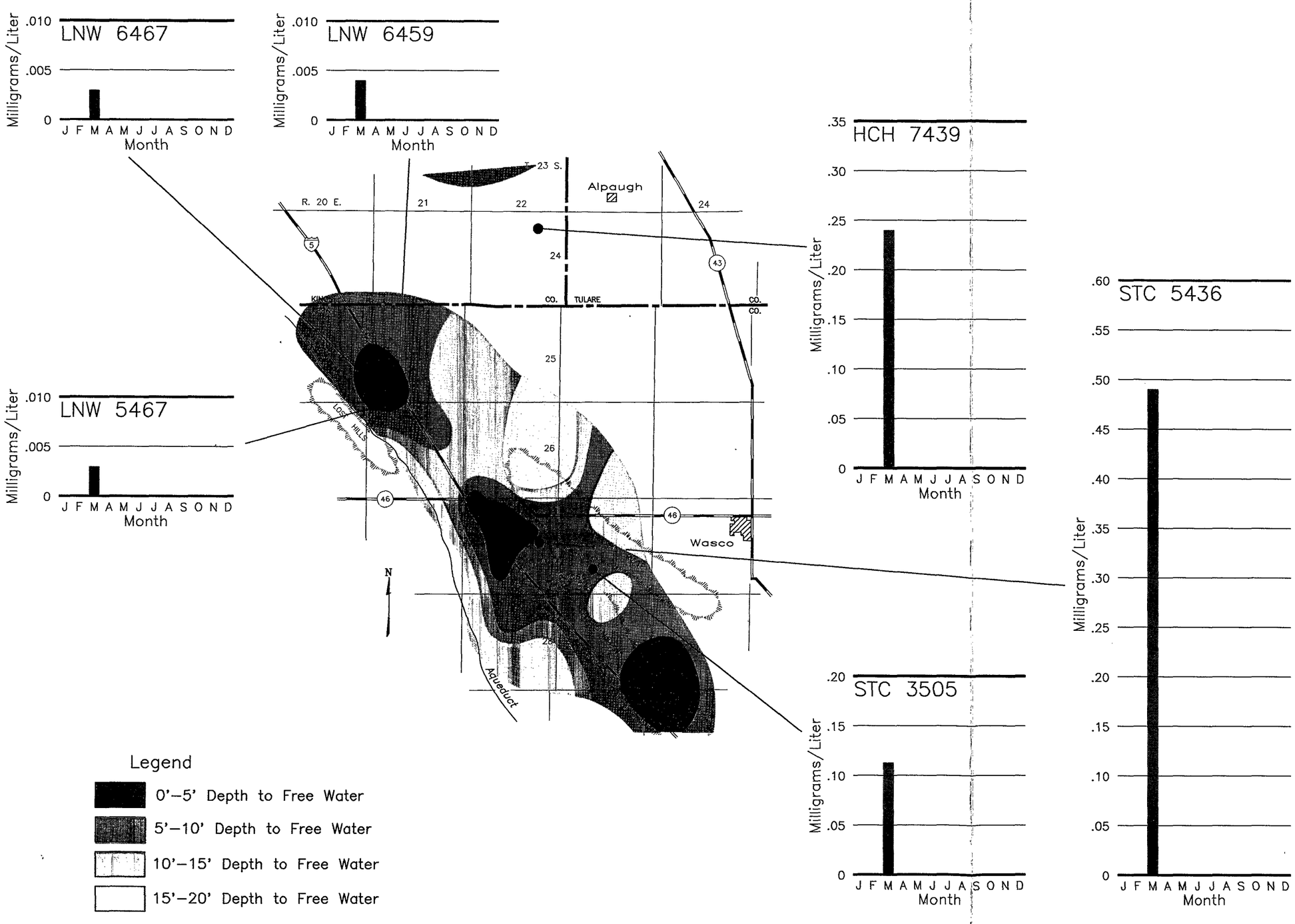
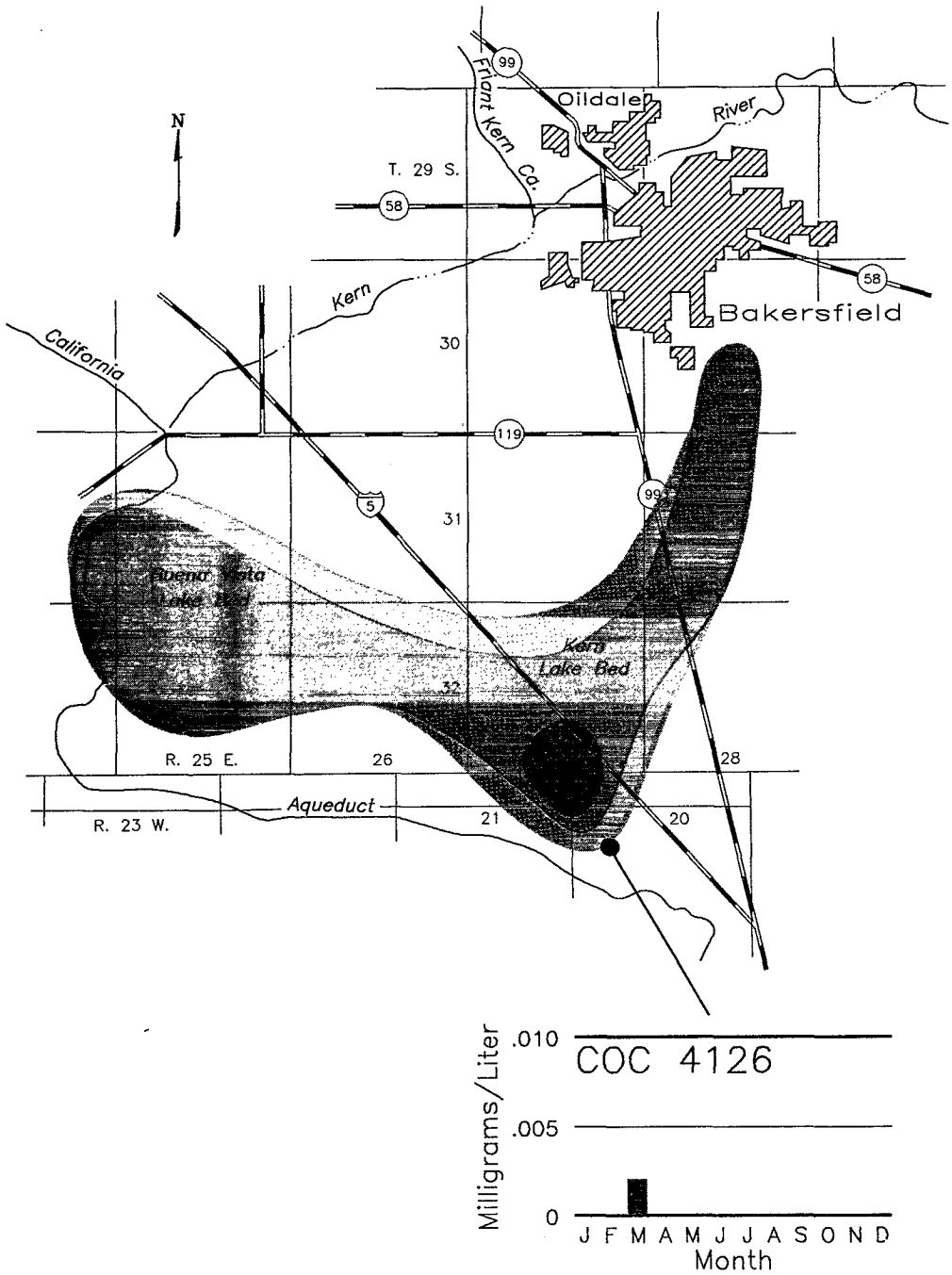


Figure 6. 1992 Arsenic Levels – Southern Area, San Joaquin Valley – Lost Hills/Semitropic Stations



Legend

- 0'–5' Depth to Free Water
- 5'–10' Depth to Free Water
- 10'–15' Depth to Free Water

Figure 7. 1992 Arsenic Levels – Southern Area, San Joaquin Valley – Kern Lake Bed Stations

Molybdenum

Molybdenum is a rare element that exists naturally in some geologic formations. Molybdenum can accumulate in plants and become toxic to grazing animals. High amounts of molybdenum can also be toxic to aquatic plant life. In the central area subsurface drains, molybdenum was detected in six samples, with a maximum level of 0.134 mg/L and an average of 0.062 mg/L. Molybdenum was detected in both central area surface drains, ranging from 0.009 to 0.023 mg/L with an average of 0.016 mg/L. The southern area subsurface drains had much higher molybdenum levels. The maximum level was 1.200 mg/L with an average of 0.590 mg/L from detections at all 16 stations.

Nickel

Nickel is a suspected carcinogen and may be present in ground water that comes in contact with wastes from electroplating industries. Nickel's effect on crops and aquatic life is not well known.

In 1992, the central area had one subsurface drain with a detectable quantity of nickel of 0.007 mg/L. The central area surface drains had no detectable nickel traces. Nickel was detected in the southern area in five samples with a maximum concentration of 0.017 mg/L and an average of 0.010 mg/L.

Selenium

Selenium is a naturally occurring, nonmetallic element that can accumulate in drainage waters when there is salt leaching and a high water table near the surface. In minute amounts, selenium is considered a required nutrient in humans. Water containing a high level of selenium, however, may be injurious to livestock that drink it, causing improper bone development, alkali disease, and cerebral disorders. In addition, selenium can significantly affect fish and wildlife exposed to it. Even low concentrations, under certain conditions, have been found to cause serious harm. Since there are large concentrations of selenium in the Coast Range, drainage waters near these mountains, especially in the Panoche fan area, may have unusually high levels of selenium.

In 1992, selenium levels in the central area subsurface drains averaged 0.066 mg/L with a maximum of 0.250 mg/L. Selenium was present in both central area surface drains, ranging from 0.044 to 0.107 mg/L with an average of 0.077 mg/L. All southern area drains had measurable levels of selenium, varying from a minimum of 0.001 mg/L to a maximum of 0.900 mg/L with an average of 0.075 mg/L. Since selenium levels greater than 0.500 mg/L occurred only near station LNW 6467, the area average may not accurately show the selenium levels over the whole southern area. If station LNW 6467 is excluded from the analysis, the southern area had an average of 0.048 mg/L with a maximum of 0.412 mg/L.

Figure 8 shows the 1992 selenium levels for the central area stations with high levels around Mendota and Firebaugh. Figures 9 through 11 show 1992 selenium levels for the southern area stations. (Note that the bar graphs on these figures are configured to show minimal amounts of

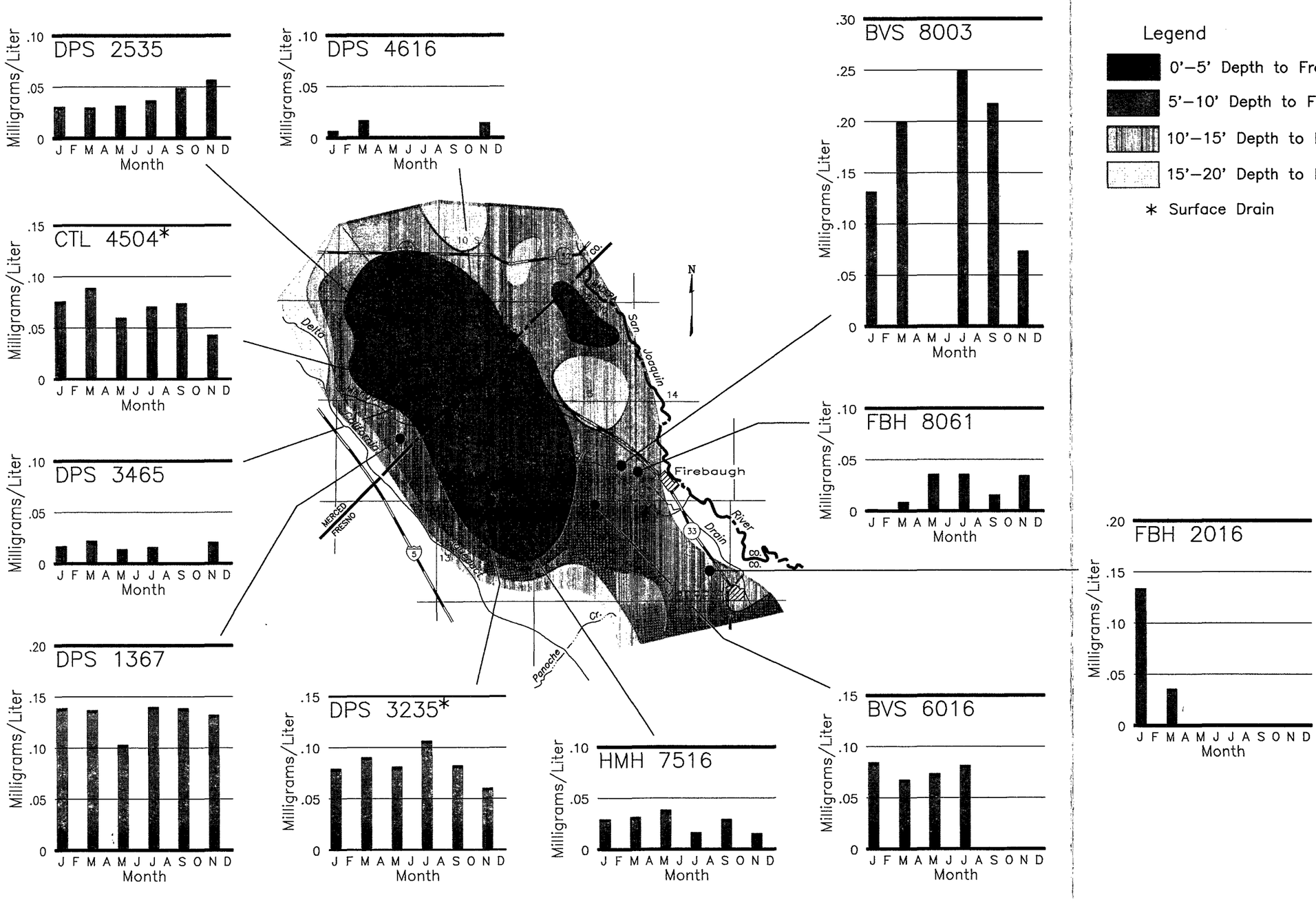


Figure 8. 1992 Selenium Levels – Central Area, San Joaquin Valley Stations

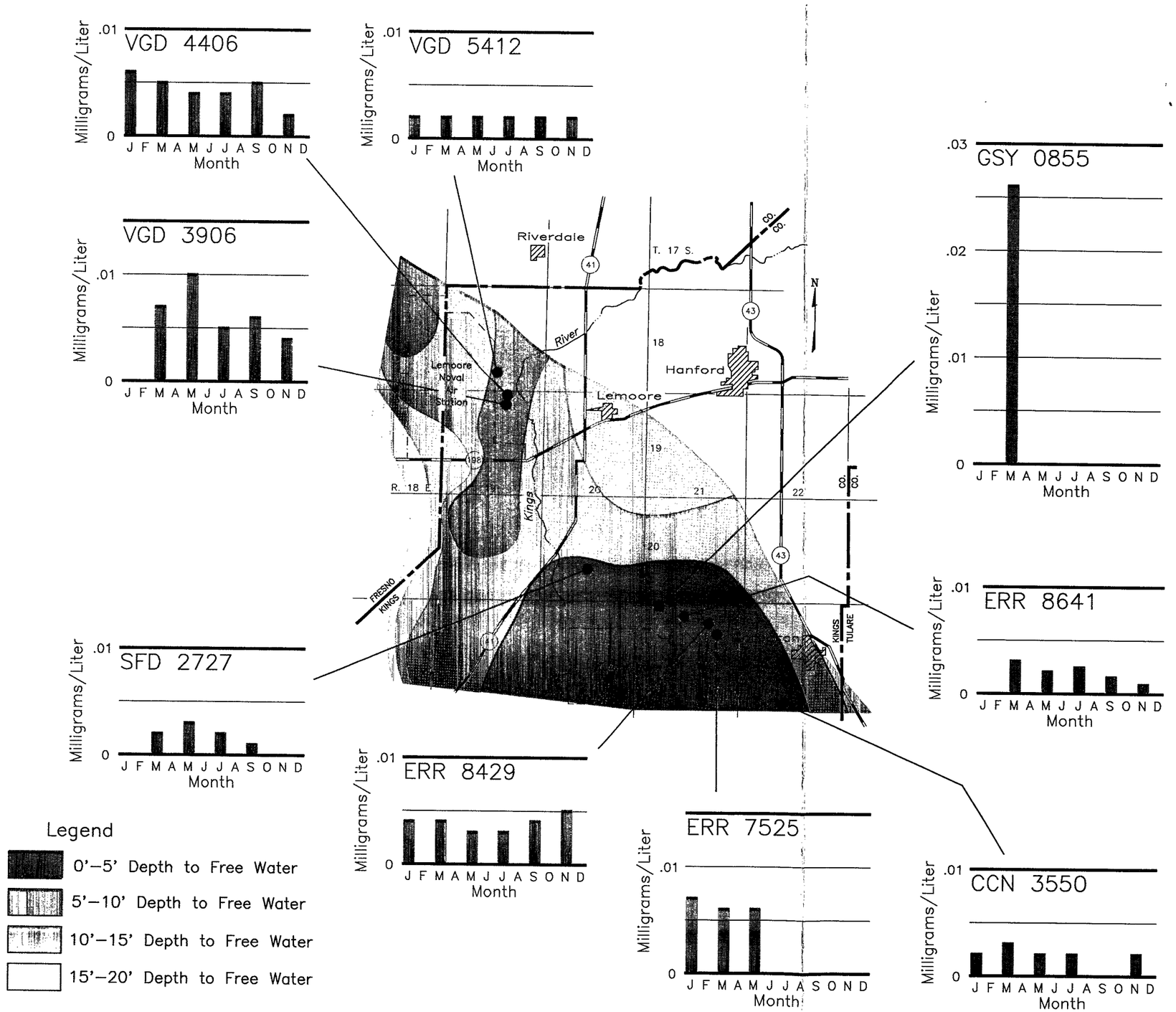


Figure 9. 1992 Selenium Levels – Southern Area, San Joaquin Valley – Lemoore/Corcoran Stations

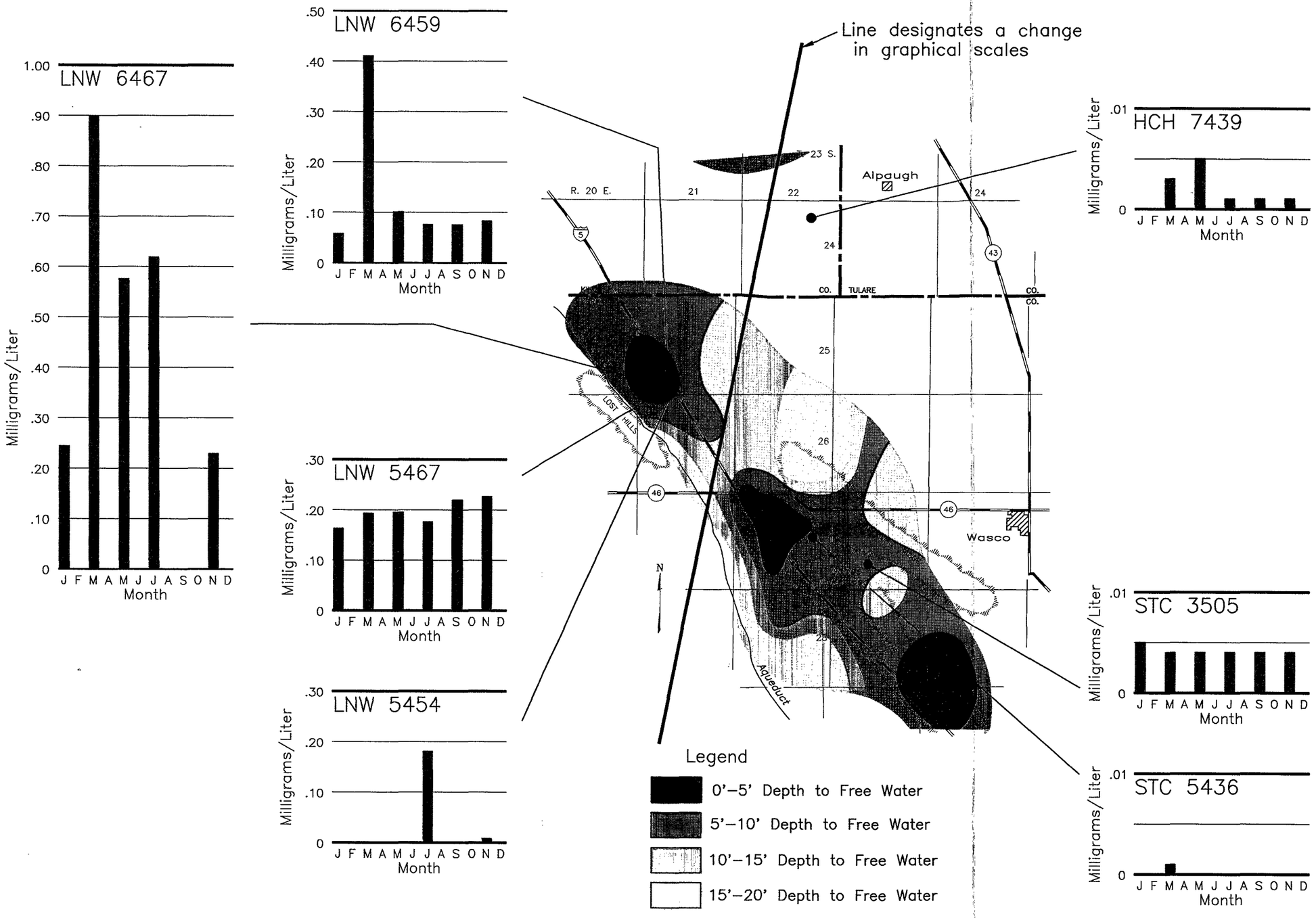


Figure 10. 1992 Selenium Levels – Southern Area, San Joaquin Valley – Lost Hills/Semitropic Stations

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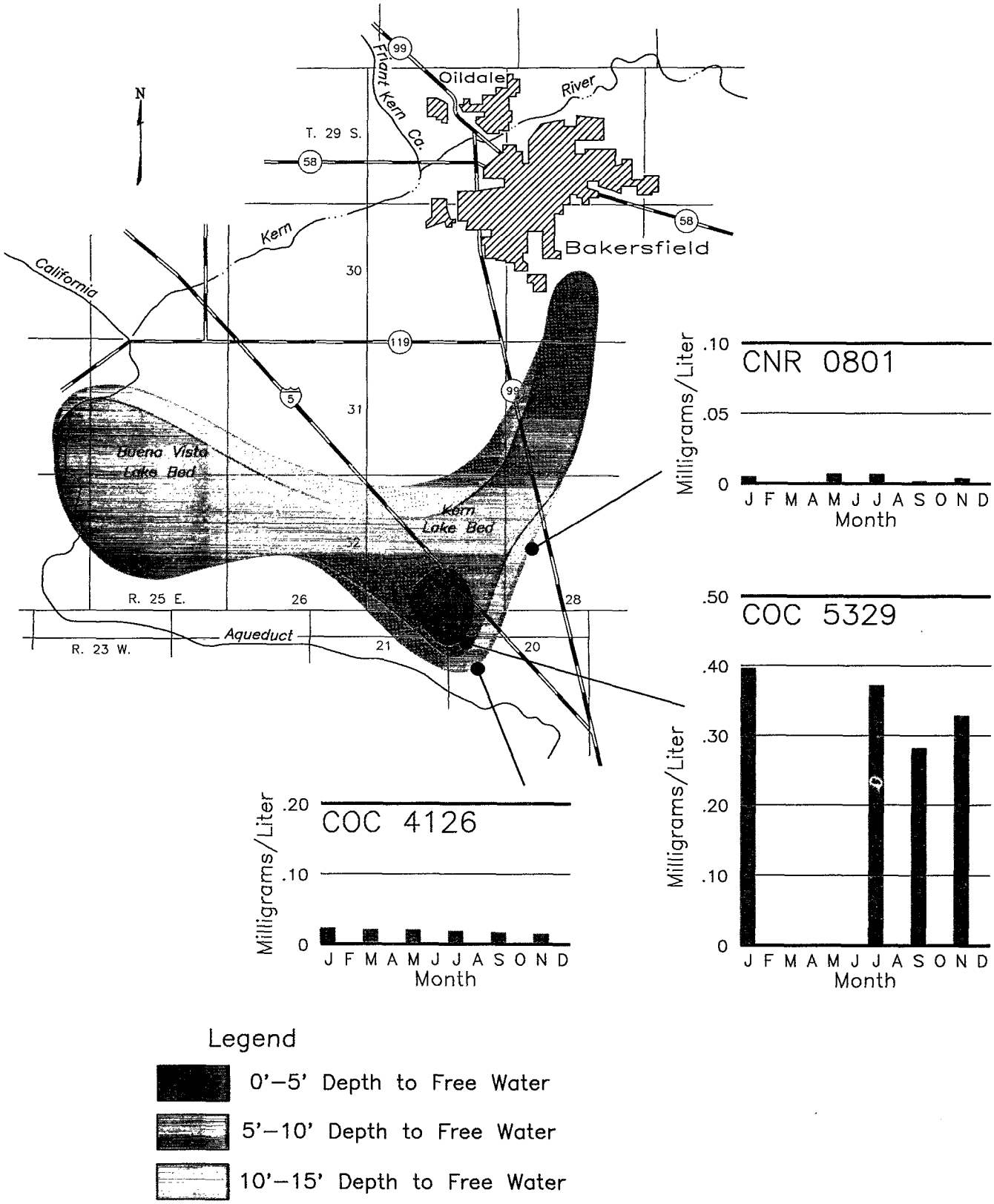

Figure 11. 1992 Selenium Levels – Southern Area, San Joaquin Valley – Kern Lake Bed Stations

selenium.) The stations near the Tulare Lake bed (Figure 9) reported relatively low selenium levels. The stations near Lost Hills (Figure 10), especially station LNW 6467, reported the highest overall concentrations of selenium for the southern area. The selenium levels around the Kern Lake bed (Figure 11) vary widely.

Strontium

Strontium is a fairly common element usually present in water in minor amounts. Although two isotopes of strontium are radioactive, drainage waters contain the nonradioactive form of strontium. The public health effects of nonradioactive strontium are not well understood; thus no water quality limits have been established. The agricultural effects of strontium in irrigation water are not well understood either, but levels higher than 200 mg/L may cause soil permeability problems.

In the central area subsurface drains, strontium was detected at all nine stations with a minimum concentration of 3.10 mg/L, a maximum of 11.00 mg/L, and an average of 5.76 mg/L. Strontium levels were lower in the central area surface drains with a maximum level of 5.20 mg/L and an average of 4.80 mg/L. In the southern area, strontium was detected at all 16 stations. The southern subsurface drains had a minimum of 0.60 mg/L, a maximum of 11.00 mg/L, and an average of 4.73 mg/L.

RESULTS OF GROUND WATER SYNOPTIC STUDY

The U.S. Geological Survey in cooperation with DWR completed a ground water synoptic study in the Tulare Basin in 1989 and published the results in a 1993 report entitled *Water-Quality Data for Shallow Wells in the Western and Southern Tulare Basin, San Joaquin Valley, California, May to August 1989*. The study showed that the quality of shallow ground water in the basin is characterized by a high degree of variability. Concentrations of dissolved solids range from 176 to 91,900 mg/L, with a median concentration of 4,440 mg/L. Salinity, expressed as specific conductance, ranges from 288 to 102,000 µS/cm, with a median of 5,450 µS/cm. By comparison, drinking water typically is less than 750 µS/cm, irrigation water is less than 1,250 µS/cm, and sea water is about 50,000 µS/cm.

Sodium is the dominant (50 percent or greater) major cation in 89 of the 117 wells sampled, calcium is dominant in 8, and magnesium in 2. There is no dominant cation in 18 of the wells sampled. Sulfate is the dominant anion in 68 of the 117 wells sampled, bicarbonate is dominant in 18, and chloride in 11. There is no dominant anion in 20 of the wells sampled.

Selenium, a trace element of primary interest in this study, ranged from less than 1 to 1,000 micrograms per liter (µg/L), with a median concentration of 1 µg/L. In contrast, selenium concentrations in the San Luis Drain, which discharged into Kesterson Reservoir until 1986, averaged about 300 µg/L. The U.S. Environmental Protection Agency water quality criterion for long-term exposure in aquatic environments is 5 µg/L, and the drinking water maximum contaminant level is 50 µg/L.

1993 MONITORING PROGRAM

The 1993 drainage monitoring program will be similar to the 1992 program. All minerals sampled for in 1992 will continue to be sampled for in 1993. Trace elements sampled for in 1992 will be sampled for in 1993, with continued emphasis on arsenic, molybdenum, and selenium due to their occurrence throughout the southern and central areas. In the 1993 report, some drainage stations will have historical graphs of selenium and other trace element levels. All drains monitored in 1992 will be monitored in 1993.

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EXPLANATION OF ABBREVIATIONS USED IN TABLES

Time	Pacific Standard Time on a 24-hour clock
Temp.	Temperature of water at time of sampling in degrees Celsius (°C) and degrees Fahrenheit (°F)
pH	Measure of acidity (<7) or alkalinity (>7) of water
EC (µS/cm)	Electrical conductance in microsiemens per centimeter at 25° C

Mineral constituents:

B	Boron
Ca	Calcium
CaCO3	Calcium carbonate
Cl	Chloride
K	Potassium
Mg	Magnesium
Na	Sodium
NO3	Nitrate (unfiltered)
SO4	Sulfate
T. Alk.	Total alkalinity
TDS	Gravimetric determination of total dissolved solids at 180° C
Sum	TDS approximation (for confirmation purposes) determined by addition of the following analyzed constituents: Ca + Mg + Na + 0.6 (CaCO3) + SO4 + Cl + NO3
TH	Total hardness
NCH	Noncarbonate hardness

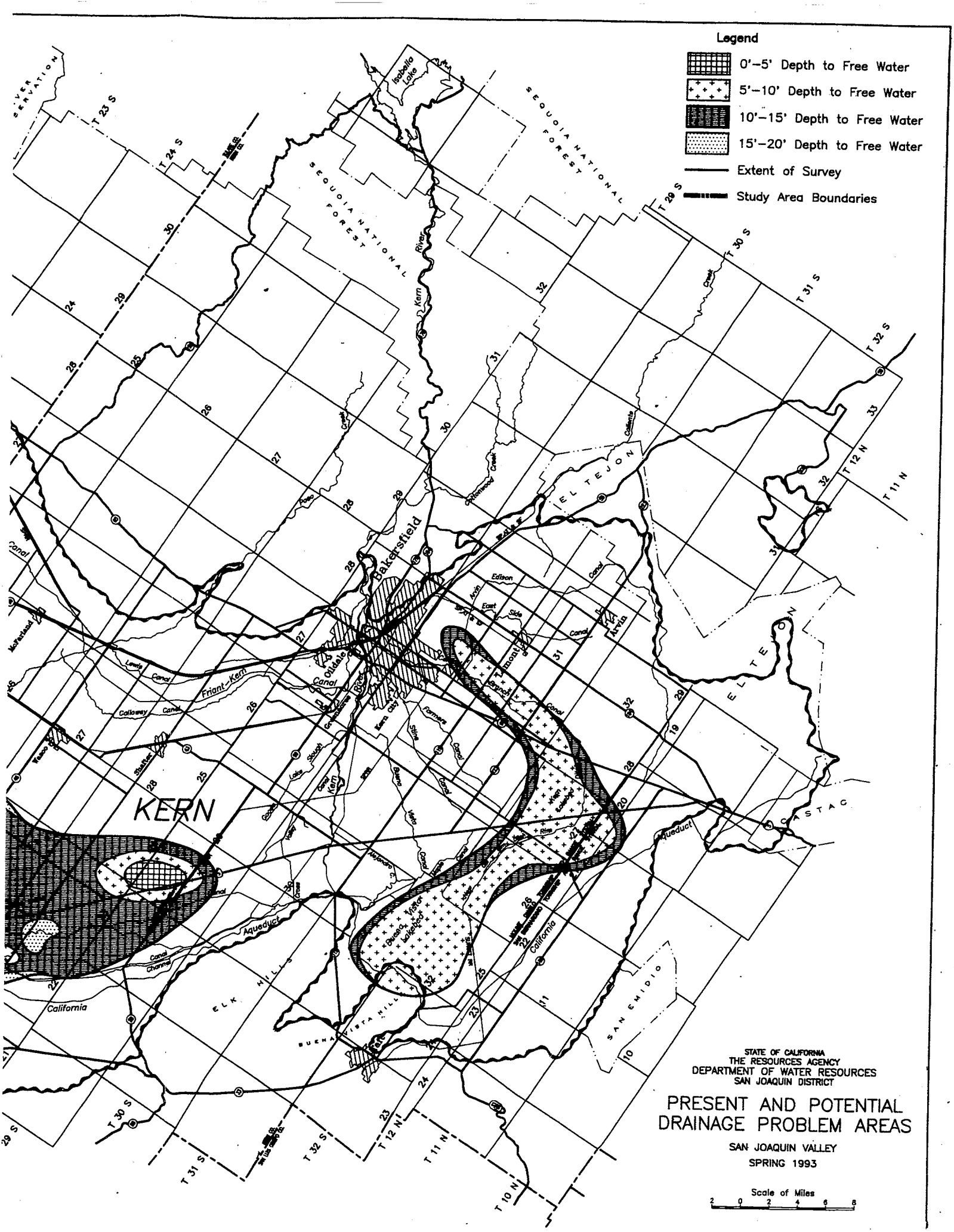
Trace elements:

As	Arsenic
Cr	Chromium (total)
Mn	Manganese
Mo	Molybdenum
Ni	Nickel
Se	Selenium
Sr	Strontium

SAR	Sodium adsorption ratio (developed by U.S. Salinity Laboratory)
ASAR	Adjusted SAR (for effects due to precipitation of calcium)

METRIC CONVERSIONS

Quantity	To Convert from Metric Unit	To Customary Unit	Multiply Metric Unit by	To Convert to Metric Unit Multiply Customary Unit by
Length	millimetres (mm)	inches (in)	0.03937	25.4
	centimetres (cm) for snow depth	inches (in)	0.3937	2.54
	metres (m)	feet (ft)	3.2808	0.3048
	kilometres (km)	miles (mi)	0.62139	1.6093
Area	square millimetres (mm^2)	square inches (in^2)	0.00155	645.16
	square metres (m^2)	square feet (ft^2)	10.764	0.092903
	hectares (ha)	acres (ac)	2.4710	0.40469
	square kilometres (km^2)	square miles (mi^2)	0.3861	2.590
Volume	litres (L)	gallons (gal)	0.26417	3.7854
	megalitres	million gallons (10^6 gal)	0.26417	3.7854
	cubic metres (m^3)	cubic feet (ft^3)	35.315	0.028317
	cubic metres (m^3)	cubic yards (yd^3)	1.308	0.76455
	cubic dekametres (dam^3)	acre-feet (ac-ft)	0.8107	1.2335
Flow	cubic metres per second (m^3/s)	cubic feet per second (ft^3/s)	35.315	0.028317
	litres per minute (L/min)	gallons per minute (gal/min)	0.26417	3.7854
	litres per day (L/day)	gallons per day (gal/day)	0.26417	3.7854
	megalitres per day (ML/day)	million gallons per day (mgd)	0.26417	3.7854
	cubic dekametres per day (dam^3/day)	acre-feet per day (ac-ft/day)	0.8107	1.2335
Mass	kilograms (kg)	pounds (lb)	2.2046	0.45359
	megagrams (Mg)	tons (short, 2,000 lb)	1.1023	0.90718
Velocity	metres per second (m/s)	feet per second (ft/s)	3.2808	0.3048
Power	kilowatts (kW)	horsepower (hp)	1.3405	0.746
Pressure	kilopascals (kPa)	pounds per square inch (psi)	0.14505	6.8948
	kilopascals (kPa)	feet head of water	0.33456	2.989
Specific capacity	litres per minute per metre drawdown	gallons per minute per foot drawdown	0.08052	12.419
Concentration	milligrams per litre (mg/L)	parts per million (ppm)	1.0	1.0
Electrical conductivity	microsiemens per centimetre (µS/cm)	micromhos per centimeter (µmho/cm)	1.0	1.0
Temperature	degrees Celsius (°C)	degrees Fahrenheit (°F)	(1.8 x °C) + 32	(°F − 32)/1.8



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